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BAYER LEVERKUSEN (GERMANY)
Department for Plant Protection

Paddy (Rice) Stem Borer *(Schoenobius incertellus* WLK) and "Folidol E 605"

by Dr. M. Puttarudriah and M. Appanna
Division of Entomology, Mysore State Department of Agriculture, Bangalore

Introduction

The paddy stem borer has been a universal pest in all the rice growing areas of the far Eastern countries. In Mysore State (India), *Schoenobius incertellus* WLK is the common and occasionally serious pest of paddy. It is commonly met with in all the paddy growing areas of the State, the incidence of the insect varying from place to place. Puttarudriah (1945) has stated that the incidence of the pest varied from 0·5 % to 12·3 % in one area on several varieties of paddy. In another area, it was found to be 16 % on a local variety of paddy (Doddi) with a thick stem. But such high percentage of incidence was noted only in patches or in certain plots. It has been observed that in areas where paddy is grown in the two seasons, monsoon and summer, the incidence of the insect is usually heavy and perceptible. Paddy crop, which is transplanted late in the season is subject to more severe attack by the insect than the crop transplanted in time.

On account of its economic importance, the insect has been studied in great detail by various workers. The insect belongs to the family *Pyralidae* under *Lepidoptera,* the parent moth having yellowish wings with a reddish tinge, and with a small black dot on each of the forewings. Eggs are laid on the blades and are covered with buff hairs derived from the tip of the abdomen. The caterpillar passes through six instars and pupates. After a pupal period of about 10 days the moth emerges (Plate). The total life cycle from egg to adult occupies from 43 to 54 days. There may be two generations in a season, the first generation attacking younger crop and the subsequent generation, at the time of earhead formation. The life-period and the number of generations depend on the seasonal conditions and vary in different places.

Various methods of control have been tried to combat this pest. Removal of plants showing "dead-hearts", and installing light-traps in the flight season of the moth, have been practised for a long time; but these methods have, at the best, served only to check the spread of the insect to a small extent. Removal of eggmasses and destruction of stubbles after harvest have been advised but not practised. During the past few years, synthetic hydrocarbons like "BHC" and "DDT", have been tried; but their use seems to be limited in that they killed only such of the different stages of the insect which came in contact with them.

Within the past decade, "Folidol E 605" — diethyl paranitrophenyl thiophosphate 46·7 %, the rest special emulsifier — an organophosphorous compound,

manufactured by Messrs. Farbenfabriken Bayer Aktiengesellschaft, Leverkusen, Germany, available in liquid and dust forms (dimethyl paranitrophenyl thiophosphate) with a vast range of insecticidal properties on a great variety of insects and with special penetrating power into the plant tissues, has been tried very extensively in Japan against *Chilo simplex* B., which is the stem borer of paddy there. It is reported that, in Japan, the pest is kept under check by spraying "Folidol E 605".

Kisabu Iyatomi (1954) has reported that in potted plant experiments spraying of "Folidol E 605" at 0·05 % gave, 4 days after spraying, an average kill of 80 % of the newly hatched larvae that were introduced to bore into the plant. On second and third instar larvae introduced to bore into potted plants, he obtained, 6 days after spraying, an average kill of 57·5 % at 0·1 % and 68·8 % at 0·05 % of "Folidol E 605". In the field tests, 7 days after spraying the same strengths, the mortality was 94·9 % and 60·3 % respectively. The kill, in the case of "Folidol" dust was 98·3 % and the larvae in the field tests had reached third and fourth instars.

Israel and Vedamoorthy (1954) have reported that seed-soaking followed by irrigation with "Folidol E 605" at 0·1 % to rice plants in plots of 3′ by 3′ gave almost complete control of the stem-borer incidence. They infer that inducing resistance to pest attack, by sap absorption of "Folidol E 605" by irrigation may be more feasible than evolving pest-resistant strains.

In Mysore, in order to exploit the penetrating property of the insecticide, trials with "Folidol E 605" were conducted against the paddy stem borer, *Schoenobius incertellus* WLK and the results obtained have been reported in this paper.

Effect of "Folidol E 605" on the eggs

"Folidol E 605" was tried at two strengths — 0·1 % and 0·06 % respectively — on the eggs of the paddy stem borer, but similar results were obtained in both the tests. Eggs collected from the field and also those that were laid on the plants in experimental plots, were subjected to the treatment. Fresh eggs were least affected, 58 % of them being killed; and the larvae having hatched out from others. It was also observed that those eggs that were near and adpressing to the substratum were affected, while those that were below the fluffy mass of hairs, on the top layers, were not affected. Eggs, about 72 hours old were comparatively more affected than those that were within 24 hours of age. It looked as though the action of the insecticide is better on the eggs very close to the green surface. These observations are being continued for elucidation of other details to assess the effectiveness of "Folidol", as an ovicide.

Effect of "Folidol E 605" on the larvae

Experimental methods

Both laboratory and field tests were conducted with several repetitions. Laboratory experimental plots were 3′ by 3′ and were planted with paddy seedlings in 5 rows with 5 plants in each row. After they were well established, the plants were artificially inoculated with paddy stem borer eggmasses for the larvae to hatch and bore into the plants. Newly hatched larvae were also introduced on to the plants. After the appearance of dead-hearts, treatment with

"Folidol" at different strengths was taken up. 24 hours and 72 hours after treatment the plants were split open and the mortality of the larvae (first instar) was recorded.

In the field tests, plots each measuring about 5·5 cents, where stem borer damage was perceptible (and the incidence being nearly 15 % in the surrounding areas) were selected and the plants, both healthy and attacked, were sprayed with "Folidol" at the formulations tried in the laboratory experimental plots. A definite number of plants — 50 in number — showing dead-hearts were removed at random from each of the treated plots with roots *"in situ"* after 24 hours and 72 hours respectively. They were dissected and examined for the effect of "Folidol" at different strengths on the larvae inside the stems. The larvae were of second and third instars in some, and still older in other plots.

Untreated control plots both for laboratory and field tests were maintained in all cases.

This method was found to be the straight method to assess the penetrating property of the insecticide through the paddy stem and its effect on the borers within. The percentage of mortality of the borers in the treated plots as compared with that in the control — untreated plots — was calculated by counting the total number of larvae and the number dead, and alive, for all plants examined.

Results of experiments

The results of all the experiments are tabulated below:

Laboratory Tests

Experiment I: Variety (S. 1092) Bangarkovi
Age of Crop: 2—2½ months old before earhead formation.

% strength of "Folidol" used	No. of plots	Average percentage of mortality after 72 hours	
		Treated	Control
0·05	2	91·6	4·3
0·025	2	100.0	4·3
1·5 (Dust)	1	20·8	4·3

Experiment II: Variety (S. 1092) Bangarkovi
Age of Crop: 3—3½ months old in earheads.

% strength of "Folidol" used	No. of plots	Average percentage of mortality after 24 hours	
		Treated	Control
0·05	2	95·0	3·8
0·025	2	100·0	3·8

Field Tests (a) Yelahanka

Experiment III: Variety (S. 197 and 199) Alursanna
Age of Crop: 1—1½ months old before earhead formation.

% strength of "Folidol" used	No. of plots	Percentage of mortality after 72 hours	
		Treated	Control
0·1	1	81·8	21·4
0·05	1	85·7	21·4
1·5 (Dust)	1	85·7	21·4

Experiment IV: Variety (S. 1092) Bangarkovi
Age of Crop: 3—3½ months old, in earheads.

% strength of "Folidol" used	No. of plots	Average percentage of mortality after 72 hours	
		Treated	Control
0·1	2	98·0	16·6
0·05	2	96·0	16·6
0·025	2	92·5	16·6

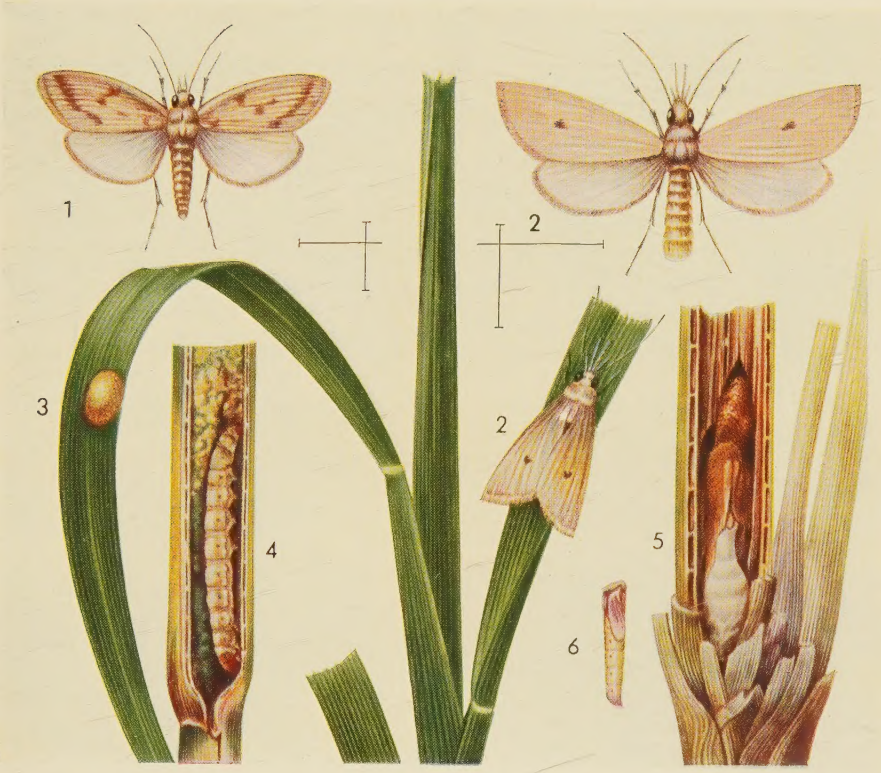
Experiment V: Variety (S. 1092) Bangarkovi
Age of Crop: 4—4½ months old in earheads, ready to be harvested.

% strength of "Folidol" used	No. of plots	Percentage of mortality after 24 hours	
		Treated	Control
0·05	1	42·3	1·5
0·025	1	47·9	1·5

In this test, a number of borer larvae were found to be in the prepupal and pupal stages at the bases of plants. The borer larvae which had not gone down the stem for pupation were the ones that were killed. Those that were found at the base were not affected by the spray. It looked that "Folidol" did not have any effect on grown up larvae which were about pupate, and also on the pupae, found at the bases of plants. This requires further studies.

Experiment VI: Variety (S. 1092) Bangarkovi
Age of Crop: 3—3½ months old in earheads.

Fifty plants with chaffy, white earheads were cut at the base and dipped in "Folidol" 0·1 % for 2 minutes, and another batch of 50 similar plants were kept untreated for check. The stems were split open after 24 hours and the



Schoenobius incertellus (Walk.) = *S. bipunctifer*

1: Male moth
2: Female moth
3: Egg mass
4: Caterpillar
5: Cocoon in stem of infested plant
6: Pupa

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mortality of the larvae was noted to be 88·2 % in the treated plants as against 6·9 % in the untreated check plants.

Experiment VII (B): Visveswaraiah Canal Farm, Mandya
Variety (S.R. 26-B)
Age of Crop: 1½ months old, before earhead formation.

Paddy plots each measuring one cent in extent were laid out in the above Research Station, for conducting tests with certain insecticides against paddy stem borer. "Folidol E 605" was also tried at two strengths each in 5 replications.

% strength of "Folidol" used	No. of plots	Percentage of mortality after 48 hours	
		Treated	Control
0·06	5 (randomised)	87·6	2·3
0·06		91·2	1·9
0·06		89·7	4·2
0·06		88·5	3·5
0·06		92·3	4·3
		Average 89·86 (90·0)	3·24 (3·0)

% strength of "Folidol" used	No. of plots	Percentage of mortality after 48 hours	
		Treated	Control
0·03	5 (randomised)	98·1	2·3
0·03		90·6	1·9
0·03		87·1	4·2
0·03		86·2	3·5
0·03		94·3	4·3
		Average 91·26 (91·0)	3·24 (3·0)

Experiment VII (C): Hebbal-Bangalore. Central Research Station
Variety (S-749) Rathnachoodi
Age of Crop: 4—4½ months old, in earheads, ready to be harvested.

% strength of "Folidol" used	No. of plots	Percentage of mortality after 24 hours	
		Treated	Control
0·05	1	28·0	2·3
0·025	1	40·0	2·3

It was observed that the borers were grown up and about to pupate at the bases of plants, and were not affected.

"Folidol" — its effect on borers, when applied by irrigation

These trials were conducted in the laboratory both in pots and cisterns the latter measuring 3′ by 3′. Paddy seedlings, about 4 weeks old, were transplanted into these, and "Folidol" was applied by irrigation method. The strength and quantity of "Folidol" used, were 0·1 % and 4545 c.c. per application for the unit area of 3′ by 3′ and 150 c.c. for a pot measuring 14″ diameter. The method adopted was to drain the water about 15—18 hours prior to application of "Folidol"; and once again to water the plants 24 hours after the insecticide was administered. The application of the insecticide was commenced two weeks after transplantation of seedlings when they were about six weeks old. Weekly applications were continued, though the plants were free from borer damage. When the plants were two months old they were artificially inoculated with the insect both by sticking large numbers of eggmasses for larvae to hatch and bore into the plants, and also by transferring newly-hatched larvae on to the plants. While infection was being enforced, the insecticide was applied regularly at weekly intervals. When earheads were put forth it was observed that a large number of them turned chaffy. At this stage, a few plants were split open and examined for borer larvae which were found to be alive inside the stems.

Then the paddy plants in the cisterns were separated into two halves. One lot, at the earhead stage was sprayed with "Folidol" at 0·025 % in addition to being irrigated regularly, while the other half was irrigated with the same strength of the chemical, and not sprayed. The plants with chaffy earheads in both the halves were dissected and examined. It was found that in the sprayed plants the percentage of mortality of the larvae was 97 while that in the irrigated half was only 12·5.

Our observations in this respect were at variance with those of Israel and Vedamoorthy (1954). Even the manufacturing company, Messrs. Farbenfabriken Bayer Aktiengesellschaft, Leverkusen, Germany, has not claimed anywhere, this property for this product. In their survey of the literature on the insecticide and acaricide "E 605", the manufacturers have stated that references have been made to its translocal effect following treatment of leaves or roots, but "in all cases, however, it is mentioned as being slight". It is also mentioned in their survey, that following application of "E 605", pests inside fruits have often been found dead.

In any case, this property of "Folidol E 605" requires further investigation.

General observations

Paddy fields round about Bangalore were frequently inspected for borer damage. It was observed that plots which had received a spray of "Folidol" at 0·025 % against paddy thrips, *Thrips oryzae* W., or caseworm, *Nymphula depunctalis* Gr., were found to be comparatively free from borers than those which had not received any spray. In an area of seven acres at Yelahanka the insect appeared in a severe form and the late transplanted paddy was subjected to the attack by the pest. Heavy egglaying was observed, as also large numbers of moths were seen on the blades; light traps were installed and nearly 3000 moths and 2000 eggmasses were collected. Though the number of moths and eggmasses was reduced, there were still many eggmasses on the blades. The grower was advised to spray "Folidol" at 0·025 % and repeat the spray at weekly intervals for two weeks. The plants, after the sprays

were given, turned dark green, a healthy sign, and put on growth. Further incidence of the pest was observed to be definitely less than before. The crop was saved and the grower reaped a good harvest.

In all the paddy plots sprayed with "Folidol E 605" liquid and dust, at different strengths, it was observed that a large number of paddy borer moths, caseworm moths, skipper caterpillars *(Parnara mathias* F.), crabs, frogs, tadpoles and many other such casual external feeders, were dead, and the moths had dropped on to the water in the plots.

"Folidol E 605" at 0·025 % had also given excellent results against paddy thrips, a serious pest on young crops immediately after transplantation and many growers took advantage of this insecticide in controlling this pest.

Conclusions

(1) Paddy stem borer eggs nearer the substratum on the green blade were found to be more vulnerable to the action of "Folidol E 605" when sprayed, than those found below the fluffy mass of hairs. Older eggs were more easily affected than fresh ones.

(2) "Folidol" in the concentration of 0·025 % was found to be as effective as 0·1 % against the borer larvae inside the stems. The lower strength had the same amount of penetrating and insecticidal property as at higher strength.

(3) Paddy stem borer grown up larvae which had gone to the base of the plants for pupation were not affected by the spray.

(4) There is a possibility of utilising this chemical as a spray on the stubbles after harvest, to kill the lurking borer larvae and arrest further multiplication of the insect in the subsequent seasons.

(5) The use of "Folidol E 605" spray against paddy thrips, caseworm, and other external feeders has an indirect favourable effect in reducing the borer incidence.

(6) About three to four sprays at definite intervals during the growth of the crop, synchronising with the emergence of the adult insect and large scale egg-deposition will protect the crop from the ravages of the stem borer.

(7) "Folidol", when applied by irrigation, did not give the same beneficial results as when sprayed on the plants.

(8) "Folidol" spray or dust when used on paddy plants will also kill crabs and other animal pests which sometimes become a nuisance to the crop.

(9) "Folidol" 1·5 % dust except in one test, on young plants, was not found to be effective in killing the borer larvae inside the stems. This was, as could be expected. But dusting would be useful in killing moths and stages of insect before they bore into the plants.

(10) No phytotoxic effect due to "Folidol E 605" was observed in any of these tests.

(11) No extra precaution while spraying was taken by the workers except care was taken not to spill the liquid on the exposed parts of the body, and not to spray against the wind. No protective apparels were used. No ill-effects were noticed by the workers except that in one case, burning of eyes for a day, was felt; burning of skin when spilt was also felt; but thorough washing relieved it.

Recommendations

Based on the results of the above experiments, the following recommendations are made to the paddy growers in Mysore State, in the control of the stem borer.

(a) Seedlings which are about 15—20 days old in the nursery may be sprayed with "Folidol E 605" at 0·02 % (a teaspoonful of "Folidol" in five gallons of water).

(b) At the time of transplantation, seedlings in small bunches may be dipped in "Folidol" 0·025 % from the tips till the bases and then transplanted.

(c) In badly infected areas, one spray with "Folidol" at 0·05 % (a teaspoonful of "Folidol" in 2½ gallons of water) may be given a month after transplanting. This applies only to badly infected areas.

(d) At the time of earhead formation a spray of "Folidol E 605" at 0·05 % is a necessity to prevent and kill the borer larvae. This will reduce the number of white chaffy earheads.

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The authors are thankful to Sri. Y. L. Gopala Gowda, Land Lord, Yelahanka, in whose fields the trials were conducted, and Sri. Rangaswamy of M/s. Rangaswamy & Co., for all their help and cooperation in conducting these field tests; Sri. M. N. Shivalingappa, Laboratoryman of the Division of Entomology, Mysore State Department of Agriculture, Bangalore, and Sri. Y. K. Rajanna of Yelahanka sprayed the plants in these experiments and thanks are due to them.

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Phytopharmacology of the Rice Diseases

The Organic Mercury Dust as a Foliage Fungicide for the Rice Crop *)

By Prof. Dr. Yoshio Hashioka and Kenzô Andô, Gifu Univ., Japan

It is quite important to establish the simple and efficacious method of control of the foliage diseases of rice, the second important food crop in the world. Since 1951, the senior author has been studying the fundamental problems concerning application of the dust fungicides to the rice crop, since spraying of Bordeaux mixture and other copper fungicides which have long been applied in Japan is not suitable for the paddy field because of the requirement of heavy labour, feeble fungitoxicity and severe phytotoxicity. In the previous paper (Hashioka *et al.*, 1953), it was confirmed by means of the clear zone method that the inhibitory action of the organic mercury fungicides to the important pathogenic fungi of rice plants is more distinct in comparison to that of the other fungicidal substances, such as zineb, thiram, 2·3-dichloro-1·4-naphthaquinone, copper dusts and Bordeaux mixture. In this paper, the excellent protective and therapeutic actions of the organic mercury dusts, *i. e.*, "Ceresan", to the blast and brown spot are discussed, and further the practical method of application of it to the foliage of rice is established based upon the different experiments *in vitro* as well as *in vivo*.

1. Materials and Methods

Four dust fungicides which are different in the chemical constituents were employed for various experiments, but Bordeaux mixture and the copper-mercury spray fungicide were also used for comparison. They are as follows:

1. Bordeaux mixture (1 lb. of copper sulphate [453 g] and 2 lb. [906 g] of calcium oxide to 108 l of water, without sticker).
2. "Ceresan" (organic mercury dust), manufactured by Nihon Tokushu Nôyaku Seizô Co. The active ingredient of the dust is phenylmercuric acetate, but, unless otherwise mentioned, this was used after dilution with slaked-lime of 5-fold in weight so as to increase the volume of dust and cancel the phytotoxicity.
3. Zineb dust. In the present experiment, however, the dust which was reprepared by Nissan Kagaku Co. so as to contain 3·9 % of zineb was used.
4. Thiram dust *i. e.* 50 % tetramethyl-thiuram-disulfide, manufactured by Du Pont Co.
5. Copper dust which contains 11 % of basic copper sulphate, manufactured by Sankyô Co.
6. Copper-mercury spray fungicide which contains 29 % basic copper sulphate and 0·3 % of phenylmercuric acetate, manufactured by Sankyô Co. This was tested *in situ* as dust.

*) Contribution No. 2 of The Laboratory of Plant Disease Science, Faculty of Agriculture, Gifu University, Gifu, Japan.

The experiments were conducted with the blast fungus *Piricularia oryzae* Cav. and the brown spot fungus *Cochliobolus miyabeanus* (Ito et Kurib.) Drechsl., which were isolated from the living rice leaves and cultured successively on the potato sucrose agar. But in the limited experiments the wild fresh conidia collected in the paddy field were also used for comparison because of their higher germinability as well as severe pathogenicity.

2. *In Vitro* Tests on the Preventive Action of the Organic Mercury Dust in Comparison to that of the Different Fungicides

The slide glasses were dusted with the different fungicides by use of a large bell jar (80 cm in height and 50 cm in diam.) according to the method of Nishikado *et al.* (1950). The jar was laid flat and 10 slide glasses to be dusted at one time were placed at the bottom side of the jar. One g of the material was dusted for every 10 glasses through the top opening of the jar by means of air pressure by use of atomizer and the bottom of jar was sealed for 3 min. during and after dusting so as to make the dust sink uniformly on the slides. Amount of the dust per 1 cm^2 of the glass surface was slightly different according to the difference of fungicides. e. g., 0·15 mg in "Ceresan" but 0·14 mg in Sankyô's Bordeaux. The dusted glasses were kept under the laboratory conditions (24—29° C) and after a lapse of a definite period, germinability of conidia of the blast fungus on the dusted glasses was observed by means of mounting the conidial suspension on the glasses and keeping them at 27° C for 20—24 hours.

Table 1: Germinability of conidia of the blast fungus *Piricularia oryzae* on the dusted slide glasses at the different lapse of days after dusting.

Fungicide	Days after dusting (Date of observation)			
	1 (Aug. 5) %	7 (Aug. 11) %	21 (Aug. 25) %	37 (Sept. 10) %
Control (Non-dusting)	94·8	85·0	100·0	100·0
Bordeaux mixture	44·0	83·3	100·0	100·0
"Ceresan" (Org. mercury dust)	3·6	6·6	38·0	89·7
Zineb dust	9·7	12·1	10·8	10·8
Copper dust	25·0	70·1	75·8	95·2

As shown in the above table, the preventive action of the organic mercury dust ("Ceresan"-lime) and the zineb dust was evident for 2 and 5 weeks, resp., after dusting, while the copper dust 11 % and Bordeaux mixture permitted the fungal germination at the considerable extent even just after application, though elongation of germ-tubes and appressoria formation was considerably limited. When the conidia were in contact with "Ceresan" and zineb-dust,

they became blackish and shriveled, and the germ-tubes were very short if they could germinate. While on the glasses sprayed with Bordeaux mixture, most of the conidia germinated almost normally even after 1 week.

A similar experiment was also conducted with the brown spot *Cochliobolus miyabeanus*, though in this case the amount of the dusts was limited to 0·5 g for every ten slides.

Table 2: Germinability of conidia of the brown spot fungus on the dusted slide glasses at the different lapse of days after dusting.

Fungicides	Days after dusting (Date of observation) Expt. 1		Expt. 2	
	1 (Aug. 15) %	21 (Sept. 4) %	1 (Nov. 1) %	7 (Nov. 8) %
Control (Non-dusting)	84·2	83·7	90·0	98·2
Bordeaux mixture	3·5	14·6	7·6	14·9
"Ceresan" (Org. mercury dust)	3·9	6·2	2·6	13·4
Zineb dust	4·4	10·3	8·2	14·5
Thiram dust			4·2	15·8
Copper dust	7·0	10·9	9·5	10·1

According to this experiment, the mode of resistance of the brown spot fungus to the different fungicides is considerably different from that of the blast fungus, namely, the germinability of the brown spot conidia is repressed by any of the fungicide tested, though the difference of grade of repression between "Ceresan"-lime and the other fungicides became somewhat larger with the lapse of days.

3. The Carrier Suitable for the Organic Mercury Dust when Applied to Foliage

In order to apply "Ceresan", the dry seed dressing dust, to the foliage of the rice plants, a series of experiments were conducted on the dilution of the original dust with the different carriers so as to reduce phytotoxicity and to make difficult to be washed away by dew and rain. The "Ceresan" dust which was diluted with slaked lime, talc, kaoline or diatomite in the ratio of 1:5 in weight, was dusted on the slide glasses by the following different methods.

1. Normal dusting under the dry condition
2. Distilled water was atomized on the dusted slides just after dusting
3. Dusting on the slide glasses coated with minute water drops by means of atomizing.

Table 3: Relation of presence or absence of water drops on the slide glasses at the time of dusting to vicissitude of fungitoxic action of the different fungicides to the conidial germinability of the blast fungus. (Percentage of germination.)

Fungicides/Treatment		Dusting under dry condition			Dewing after dusting			Dusting on dew drops		
		Days after dusting			Days after dusting			Days after dusting		
		3	15	30	3	15	30	3	15	30
Non-dusting		*97·3	*100·0	*100·0	*97·3	*100·0	*100·0	*97·3	*100·0	*100·0
Bordeaux mixture	Control	71·6	90·1	*100·0	87·4	100·0	*100·0	85·3	100·0	*100·0
	Dipping	86·8	100·0	*100·0	89·9	100·0	*100·0	94·9	100·0	*100·0
Zineb dust	Control	12·4	12·1	100·0	16·5	5·9	86·2	8·9	12·4	12·3
	Dipping	*95·9	*100·0	*100·0	26·3	25·8	100·0	21·0	74·8	100·0
Copper dust	Control	33·9	85·4	86·9	79·3	91·0	*100·0	87·1	60·5	89·7
	Dipping	*94·5	100·0	*100·0	55·2	* 93·0	100·0	54·1	75·8	*100·0
Org. Mercury dust "Ceresan"-slaked lime	Control	6·4	9·9	*100·0	14·7	21·3	83·2	11·7	27·0	91·7
	Dipping	9·2	100·0	*100·0	17·7	82·4	*100·0	13·0	92·3	93·7
"Ceresan"-talc	Control	7·3	100·0	*100·0	44·4	* 90·0	*100·0	23·2	85·7	*100·0
	Dipping	*97·8	*100·0	*100·0	94·1	*100·0	*100·0	*94·3	100·0	*100·0
"Ceresan"-kaolin	Control	11·7	100·0	*100·0	12·5	79·5	*100·0	39·7	*100·0	*100·0
	Dipping	88·5	100·0	*100·0	*88·8	*100·0	*100·0	91·4	*100·0	*100·0
"Ceresan"-diatomite	Control	13·0	100·0	*100·0	18·8	93·3	*100·0	18·8	*100·0	*100·0
	Dipping	18·8	*100·0	*100·0	75·0	100·0	*100·0	88·6	*100·0	*100·0

* mark means formation of appressoria.

Half the number of the slides thus prepared *i. e.*, 5 slides for every plot, were further dipped in tap water streamed in the shallow (5 cm deep) water bath (22° C), and the dust was allowed to be washed away for 1 min. These slides were kept under the laboratory condition of midsummer, and the maintenance of fungitoxicity of those different plots was tested after the different lapse of days by means of mounting the conidial suspension of the blast fungus on those slides. The results of this series of experiments are summarized in table 3.

It was found that, in general, the fungicidal dusts become adhesive to the slides by presence of water drops, but the grade of adhesion is quite different according to the kind of fungicides and of carriers used. The zineb dust and "Ceresan"-lime hardly lose their fungitoxic action for a long time even if they are dipped in water, but if "Ceresan" is diluted with talc, kaoline or diatomite its action becomes quite inferior to that diluted with slaked-lime even under the dry condition, still more in water.

Then the next problem is to determine the suitable dilution of "Ceresan" with slaked lime. Germinability test was therefore made with the conidia of the blast fungus by means of the slides dusted with "Ceresan" diluted in slaked lime at the different ratios in weight, *i. e.*, 1:5, 1:7·5, 1:10 and 1:15, and the percentage of germination was observed at the different lapse of days after dusting.

Table 4: Germinability of the conidia of the blast fungus on the slides coated with "Ceresan"-slaked lime at the different dilutions.

Ratio of "Ceresan"-slaked lime	Days after dusting (Date of observation) 1 (Oct. 8) %	14 (Oct. 21) %	31 (Nov. 7) %
Control (Non-dusting)	96·7	77·1	86·2
1:5	6·6	10·3	75·6
1:7·5	10·2	23·2	78·8
1:10	13·0	37·5	83·5
1:15	14·7	32·8	87·0

Although the efficacy of "Ceresan" decreases in proportion with dilution, but, as seen in the above table, the grade of decrease is rather slight, and it is considered that the proper dilution for the field dusting is 5 to 7·5-fold.

4. *In Vivo* Tests on the Preventive action of the Organic Mercury Dust in Comparison to that of the Different Fungicides

a) Germinability of conidia of the blast and brown spot fungus on the dusted leaves

The pottet rice plants (Var. Nôrin No. 1, ca. 40 cm in height) were dusted with different fungicides (1 g for 4 plants) by use of the jar which was already stated. Then the leaves were cut ca. 5 cm in length, and two of those cut

leaves were kept in a moistened petri dish, two drops of spore suspension being mounted on every cut leaf. After incubation at 27° C for 20 hours, germinability of the conidia was observed under a microscope by means of transferring the incubated drops on the slide glasses.

Table 5: Germinability of the conidia of the blast fungus on the rice leaves dusted with the different fungicides.

Fungicides	% of germination on the day after dusting		
	Expt. 1 (Sept. 5)	Expt. 2 (Nov. 17)	Expt. 3 (Dec. 2)
Control (Non-dusting)	97·7	96·4	90·0
Bordeaux mixture	94·0	20·6	20·3
Zineb dust	6·1	5·4	2·0
Thiram dust		6·9	1·7
Copper dust	30·1	10·8	11·1
Copper mercury fungicide		16·0	35·4
Org. mercury dust 1: carrier 5			
"Ceresan"-slaked lime	10·1	6·8	4·2
"Ceresan"-talc	24·0		
"Ceresan"-kaoline	11·5		
"Ceresan"-diatomite	32·9		

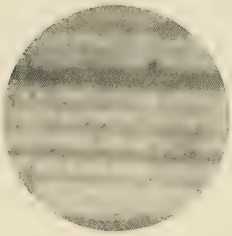
Germinability of the conidia on the rice leaves was generally larger than that on the slide glass, but the tendency of repression of germination was almost similar as *in vitro* tests.

A similar experiment was also conducted with the brown spot fungus.

Table 6: Germinability of the conidia of the brown spot fungus on the rice leaves dusted with the different fungicides.

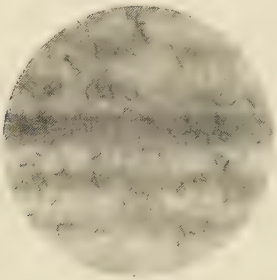
Fungicides	% of germination on the day after dusting		
	Expt. 1 (Nov. 10)	Expt. 2 (Dec. 2)	Expt. 3 (Dec. 15)
Control (Non-dusting)	93·8	88·2	82·1
Bordeaux mixture	16·3	10·3	15·3
Zineb dust	20·5		12·7
Thiram dust	9·7		11·0
"Ceresan" (Org. mercury dust)-lime	7·2	2·4	9·6
Copper dust	5·3	4·3	11·0
Copper mercury fungicide	13·7	52·5	22·2

Germination of *Cochliobolus miyabeanus* on treated paddy leaves

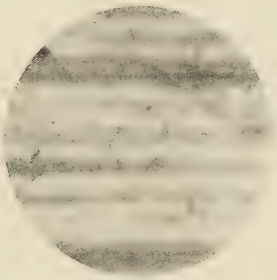


Cochliobolus miyabeanus
treated with Zineb dust

Cochliobolus miyabeanus
dusted with Bordeaux mixture

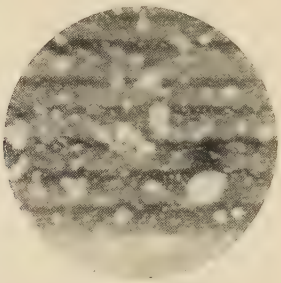


Cochliobolus miyabeanus
untreated

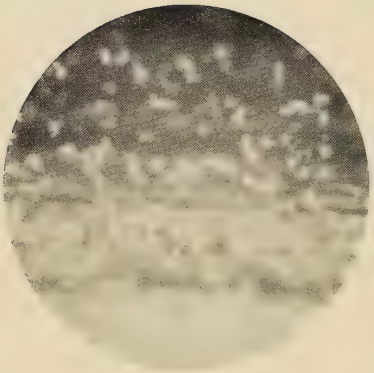


Cochliobolus miyabeanus
treated with Copper dust

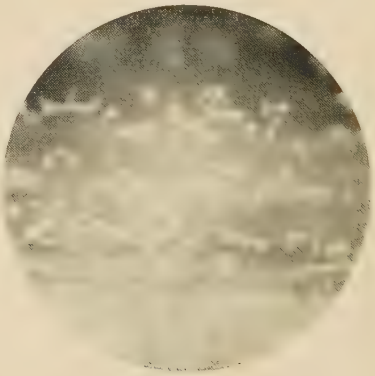
Germination of *Piricularia oryzae* on treated paddy leaves



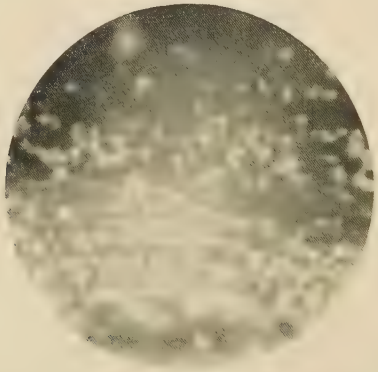
Piricularia oryzae dusted with "Ceresan"-lime



Piricularia oryzae
dusted with Bordeaux mixture



Piricularia oryzae untreated



Piricularia oryzae treated with Zineb dust

The actions of the different fungicides to the brown spot fungus seem to be somewhat different from those to the blast fungus, namely, "Ceresan"-lime was most effective and the copper dust also showed a higher efficacy, while thiocarbamates were inferior to those two formers. And such differences of the experimental data between the blast and the brown spot cannot be regarded as a result of cooler condition during the latter experiment.

b) Infection of the dusted leaves by the blast fungus

The lowland rice plants, var. Nôrin No. 8, were cultured with 1/15,000 a. porcelain pots (4 plants in each) in the glass-house. When they attained the height of ca. 45 cm, they were dusted with the different fungicides by means of the similar manner stated in the previous section. Just after dusting, they were inoculated with the conidial suspension of the blast fungus, and then incubated in the infection chamber until the lesions appeared.

Table 7: Results of the inoculation with the blast fungus on the potted plants previously dusted with the different fungicides.

Fungicides	Number of lesions per leaf	
	Expt. 1 (Var. Nôrin No. 8)	Expt. 2 (Var. Nôrin No. 1)
Control (Non-dusting)	6·8	8·3
Bordeaux mixture	5·5	7·5
Zineb dust	6·5	11·0
Copper dust	5·5	5·8
Organic mercury dust 1: carrier 5		
"Ceresan"-slaked lime	3·2	3·4
"Ceresan"-talc		5·3
"Ceresan"-kaoline		7·6
"Ceresan"-diatomite		5·5

On the living leaves, such a distinct efficacy of the fungicides as on the slide glass was not secured. In general, however, similar to the *in vitro* tests on the repression of conidial germination, the number of lesions per leaf was least on the plants dusted with "Ceresan"-lime, but considerably larger in the other three "Ceresan" plots, *i. e.*, those diluted with talc, diatomite and kaoline, and the efficacy of Bordeaux mixture and the zineb dust was almost indistinguishable, so far as the present fungicidal concentrations were concerned. Nevertheless, it is still open to doubt that the zineb dust was almost ineffective to the blast infection in spite of its distinct efficacy of repression of conidial germination.

5. Therapeutic Action of the Organic Mercury Dust

a) Effects of dusting at the incubation period (just after the invasion of the fungus into the host leaves) on the development of the disease

The potted plants (va. Nôrin No. 1) were inoculated with the conidial suspension of the blast fungus, and incubated at 27° C. After incubation of 48 hours during which the invasion of the fungus into the host tissues had been completed, the inoculated leaves were cut ca. 4 cm in length and 4 of these cut leaves were put in a large petri dish. Then they were dusted with the different fungicides and kept in the moistened condition at 27° C for 4 days. Observation was made on appearance and extension of the lesions.

Table 8: Development of the lesions of the blast disease on the inoculated cut leaves which were dusted with the different fungicides at the incubation period.

Fungicides	Appearance of lesion	Formation of aerial hyphae	Extension of lesion
Control (Non-dusting)	Normal	+	+++++
Bordeaux mixture	Almost normal	+	++++
Zineb dust	Do.	+	++++
Copper dust	Do.	+	++++
Organic mercury dust			
"Ceresan"-lime	Feeble	—	+
"Ceresan"-talc	Do.	—	++
"Ceresan"-kaoline	Do.	—	++
"Ceresan"-diatomite	Do.	—	+++

It was found by the above-named experiment that the dusting during incubation with Bordeaux mixture, the zineb dust or the copper dust is almost unable to prevent the development of lesions, while that with the organic mercury dust, especially that mixed in slaked lime, repressed greatly the development of the fungus after invasion into host.

b) Effect of dusting just after appearance of lesions on the further fungal development

Five cut leaves of the lowland variety, Nôrin No. 1, each on which one blast lesion of almost same size had appeared by inoculation, were put in a moistened petri dish and dusted with the different fungicides. Then these

dusted leaves were incubated at 27° C. After incubation of 17 and 40 hours, resp. the number of conidia per a microscopic field was counted by means of pressing the part of lesion of the leaf surface to the slide glass which was previously coated with glycerine-gelatine.

A similar experiment was also conducted with the brown spot lesions.

Table 9: Formation of conidia on the blast and brown spot lesions which had been dusted with the different fungicides just after the appearance of the lesions. (Number of conidia per microscopic field.)

Fungicides	Blast		Brown spot	
	After 17 hrs.	After 40 hrs.	After 48 hrs.	After 62 hrs.
Control (Non-dusting)	39·4	65·3	+	4·9
Bordeaux mixture	48·5	53·0	+	5·5
Zineb dust	1·4	36·8	—	1·0
Copper dust	13·8	14·1	+	3·5
Org. mercury-lime	0	0	—	0

So far as the present observations were concerned, the conidial formation on the blast and brown spot lesions was completely prevented by the "Ceresan"-lime (organic mercury dust), but not decidedly by the others. At the early stage of observation, the zineb dust seemed also efficacious, but later it was found that its efficacy is limited to the retardation of sporulation.

c) Effet of dusting with the different fungicides on the sporulation on the rotten-neck

The panicles affected by the blast disease were cut ca. 6 cm in length at the part of the neck and these cut necks were placed aslant in the moistened petri dish with aid of a small glass club. Then they were dusted with the different fungicides. After 20 hours of incubation at 27° C, the dusted rotten-neck was put in 0·05 cc of the sterilized water drop mounted on a slide, and then the number of conidia dispersed in the drop was counted under a microscope. In the expt. 3 of the following table, dusting was made on the rotten-necks which were stood upright by means of sticking them in agar coagulated in a deep petri dish.

The results of the present experiments were almost similar to those on the leaf-blast, though the grade of repression of sporulation was somewhat slighter than in the latter experiments, probably due to complete rot of the necks and difficulty of uniform coating of the necks with the fungicides. The thiram dust

Table 10: Repression of sporulation on the rotten-necks by dusting with the different fungicides. (Number of conidia per microscopic field.)

Fungicides	20 hrs. after dusting		48 hrs. after dusting
	Expt. 1	Expt. 2	Expt. 3
Control (Non-dusting)	54·9	131·1	144·0
Bordeaux mixture	33·9	62·7	123·8
Zineb dust	17·7	98·2	62·8
Thiram dust	1·2	6·7	
Copper dust	18·1	41·3	89·0
Copper-mercury fungicide	33·5	40·7	
"Ceresan" (Org. mercury)-lime	3·0	27·7	4·3

also showed a distinct repression, but such a high concentration as employed in the present experiment can not be used for practice. Be that as it may, the distinct therapeutic action of the "Ceresan"-lime at the practical concentration is considered to be an important cause of its excellent efficacy when applied in the field.

6. Experiments on the Volatile Fungitoxic Substance

It is to be desired that the fungus invaded in the leaves which are not covered with the dust, is also killed by certain volatile fungitoxic principle liberated from the dusted leaves which are adjacent closely to the former, since in the field it is very difficult to dust completely all the foliage without any omission. As to this problem, it should be ascertained whether or not the fungitoxicity of the dust fungicides is due to the presence of certain volatile substance or merely to the water soluble substance. For this purpose, the distance action of the fungicides was inspected with the use of the leaves of var. Nôrin No. 1 which had been cultured in pots until they attained the height of ca. 40 cm of which leaves were ca. 7 cm in length and 1 cm in width. Two cut pieces of those leaves were affixed to a slide glass with silk-thread at the both ends of them, and were dusted with the different fungicides after putting them in a petri dish. On the other hand, the similarly affixed leaves which were atomized with the conidial suspension of the blast or brown spot fungus were placed in the petri dish opposite to the above-named dusted cut-leaves. Two small glass rods were used as pillows so as to keep the distance between these two opposite slides as 5 mm. Such a pair of small set kept in a moistened petri dish was incubated for 20 or 24 hours at 27° C. After incubation, the atomized drops of conidial suspension hanged on the upper leaf were observed under microscope by means of mounting them on the other slides. In the early stage of this series of experiments, the paraffin rods 5 mm in width were used so as to avoid the ascending of water in the bottom of the dish to the upper leaves due to surface tension, but later it was found that such a consideration is not needed.

Table 11: Distance action of the different dust fungicides to the blast and the brown spot fungus. (Percentage of germination.)

Fungicide	Blast		Brown spot fungus	
	Expt. 1 (24 hrs.' inc.)	Expt. 2 (24 hrs.' inc.)	Expt. 1 (20 hrs.' inc.)	Expt. 2 (24 hrs.' inc.)
Control (Non-dusting)	93·5	95·6	63·2	93·2
Bordeaux mixture	90·7	92·0	69·8	90·7
Zineb dust	19·1	9·0	26·7	11·6
Thiram dust	89·1	57·3	47·5	74·1
Copper dust	96·8	95·2	38·4	90·8
Copper-mercury fungicide	95·6	93·1	78·8	89·6
"Ceresan"(Org. mercury)-lime	88·0	72·7	30·7	78·8

So far as the present experiments were concerned, the distance effect was evidenced considerably by the zineb, and slightly by the organic mercury-lime and the thiram, but scarcely by the copper dust, copper-mercury fungicide and Bordeaux mixture.

7. Discussion and Conclusion

So far as the present *in vitro* tests are concerned, germination of the conidia of the blast and brown spot fungus is repressed most distinctly by the zineb dust, and considerably by the "Ceresan"-lime (organic mercury dust). Nevertheless, under the rainy condition the former loses greatly its fungitoxic action due to washing away of the dust, while the latter maintains its action for a longer period. On the other hand, repression of conidial germination of the copper dust and Bordeaux mixture is very feeble irrespective of the presence or absence of water drops on the slide glass. Such a fungitoxic tendency of the different fungicides roughly coincides with the results of our cultural studies by means of the clear zone method (Hashioka *et al.*, 1952, 1953). The fungitoxicity of the organic mercury dust is preserved longer when it is adhered to the plants due to the presence of water drops than when dusted under the dry condition. For this reason, in the paddy field dusting at dusk, *i. e.*, just before dewing, or at the dewy morning, is effective for continuation of fungitoxicity, though the latter has a defect of non-uniformity of adhesion of dusts to the plant surface.

As regards the carrier of the organic mercury dust which enables to serve for the paddy field dusting, it was evidenced that the fungitoxicity of "Ceresan" to the blast fungus is distinctly decreased and easily washed away by water when it was diluted with talc, kaoline and diatomite, while very stable when mixed in slaked lime. Ishizaki *et al.* (1952) proved that the fungitoxic principle of corrosive sublimate to *Cochliobolus miyabeanus* is the mercuric gas, and this is easily adsorbed by talc and soy bean sticker. Similar presumption may be applied to the cause of the authors' above-named phenomenon. Consequently, it is considered that slaked lime is the most suitable carrier of "Ceresan" applicable to the paddy field. According to the field experiment of Kozu *et al.* (Chugoku-Shikoku A. E. S., 1953), the efficacy of "Ceresan"-lime to the leaf blast increases in proportion to minuteness

of particles of slaked lime used for the carrier, though the grade of increase of efficacy is not so evident at more than 100 mesh. The fungitoxicity of "Ceresan" decreases in proportion to dilution with slaked lime, but according to the present laboratory experiments 5 to 7·5-fold dilution (in weight) is considered most suitable for the foliage dusting, and this fact fully coincides with the empirical conclusion based upon many field trials (Hagiwara *et al.*, 1951; Chugoku-Shikoku A.E.S., 1953 *et passim*) of which dose is 0·5 kg of "Ceresan" into 3·0—3·5 kg of slaked lime for 10 a. of the paddy field. So far as such dilutions are concerned, almost no phytotoxicity occurred in any of the above-named field trials, except the application to the young panicles.

Therapeutic action is one more distinct charactor of the organic mercury dust in contradiction to many other fungicides most of which action is limited to the protectant. Sporulation on the blast and brown spot lesions is repressed most distinctly by the dusting of "Ceresan"-slaked lime and thiram dust, though the content of the active ingredient of the latter in the present experiments was very high (50%). A rather slight repression of sporulation was also occurred by the copper dust and the copper-mercury fungicide, but scarcely by Bordeaux mixture. Such a difference of repression of sporulation of the organic mercury spray fungicide and the copper when applied to the blast lesions was already pointed out by Fukuoka Agr. Expt. Sta. (1951) and Hagiwara *et al.*, *(loc. cit.)*, and this action of the organic mercury dust is considered to be an important cause of its prominent efficacy as a foliage fungicide.

It was proved by certain workers (Rich *et al.*, 1950; Cox *et al.*, 1951) that the fungitoxic action of the organic sulphur fungicides is due to the liberated gaseous toxicants. As already stated, Ishizaki *(loc. cit.)* found the volatile substance of corrosive sublimate which is fungitoxic to the rice brown spot fungus. In the present experiments with the blast and the brown spot fungus, it was found that the distance effect of the organic mercury dust is slighter than the zineb dust. Although further researches are needed on the mechanism of fungitoxicity of the organic mercury dust when applied to the foliage, such prominent protective and therapeutic actions of it are not considered to be due merely to the gaseous toxicant. From the comparatively sligther distance action of the organic mercury dust shown by the present study and the distinct clear zones on agar as proved by the authors' previous work, the fungitoxic action of the water soluble component of it should also be considered as the cause of efficacy. In this connection, it is noticed that the solubility of methoxyethyl mercuric chloride ($CH_3OC_2H_4HgCl$), one of the constituents of "Ceresan", to water is higher (1·9 g 100 cc, 25° C) than that of phenyl mercuric acetate ($C_6H_5HgOCOCH_3$) (0·4 g/100 cc, 25° C) and others (Nihon Noyaku K.K., 1953). Such a hydrophile character of the former is considered to play a certain role for the fungitoxic efficacy under the field conditions.

The prominent efficacy of the organic mercury dust "Ceresan"-lime to the rice blast and other rice diseases has already been proved by 37 field experiments conducted co-operatively by the 12 agricultural experiment stations in Chugoku-Shikoku district of Japan (Chugoku-Shikoku A.E.S., 1953) and certain other field trials at the different stations. According to the summarized conclusion of the above-named co-operative experiments, among

37 experiments concerning the leaf and neck-blast, 27 showed higher efficacy of the organic mercury dust in comparison to Bordeaux mixture, in 10 almost no difference was found *inter se*, and none of them resulted in inferiority of the former to the latter. In addition to such efficacy, the organic mercury dust usually accompanies almost no phytotoxicity to rice plants, except the young panicles on which the dust injury often occurs as a browning of the external appearance and slight increase of sterility of the grains. Therefore, as regards the application of this dust at the young stage of panicles, further study is needed, since this stage is most important for the prevention of the neck and ear-blast due to susceptibility of the young tissues. In this connection, it must be remembered that application of Bordeaux mixture, still more that of the other copper fungicides, usually accompanies with a considerable phytotoxicity which may result in the decrease of yield at 10 per cent grade (Tokai-Kinki A.E.S., 1953; Hashioka, 1951, 1952).

The establishment of the dust control method of the rice diseases by use of the organic mercury dust "Ceresan"-lime may contribute to the stability of the rice crop in the following points:

1. It makes easy the control operation, especially that at the most suitable and effective time due to saving of labour and simplicity of the method.
2. Common control against several important diseases is enabled by a single operation at one time, since this dust is not only quite efficacious to the blast and brown spot as stated above, but also considerably effective to the sheath spot *Corticium Sasakii* (Shirai, Mats. et Yam.) and the bacterial leaf-blight *Pseudomonas (Bacterium) oryzae* (Ueda et Ishiyama Nakata), as will be reported in the near future. Moreover, it is also very effective to the stem-rot *Helminthosporium sigmoideum* Cav., H. sig. var. *irregulare* Cralley et Tullis etc.) by means of the modified method of application, *i. e.,* dusting to the surface of irrigation water.
3. Therapeutic application is also enabled even if it is used after the appearance of the lesions, still more at the incubation period, in contradiction to the fact that in most of the other fungicides the preventive application is necessary due to their meagre therapeutic action, in spite of the difficulty of forecasting the outbreak of the diseases.

8. Summary

1. *In vitro*, the organic mercury dust "Ceresan" (diluted with slaked lime of 5-fold in weight) retain the action to repress the germination of conidia of the blast fungus for a longer period in comparison to the copper dust, Bordeaux mixture, etc. Under dry condition, the zineb dust also retains the action longer, but loses suddenly by rain. Such differences of retaining of the repressing action among the different fungicides are more distinct *in vivo* than *in vitro*, and almost similar phenomena are also seen in the brown spot.
2. But such a distinct fungitoxic action of the organic mercury dust ("Ceresan") is restricted to the case when it is diluted with slaked lime, and the action is weakened if it is diluted with kaoline, diatomite or talc. So far as the dilutions of "Ceresan" with slaked lime from 5- to 15-fold in weight

are concerned, the rate of decrease of fungitoxicity of "Ceresan" is rather small, and 1:5-dilution is considered suitable for the practical application to the leaf-blast, but for the neck-blast more diluted dust, *i. e.*, 1:7·5 should be used so as to avoid phytotoxicity to the young panicles.

3. According to the inoculation experiments with the dusted plants, the preventive effect of the organic mercury dust ("Ceresan"-lime) to the infection of leaf-blast is quite distinct in comparison to the zineb dust, the copper dust, Bordeaux mixture, etc.

4. When the different fungicides are applied to the lesions of the leaf- and neck-blast and brown spot, certain distinct therapeutic effects, *i. e.*, repression of sporulation, interruption of further extention of lesions, etc., are resulted by the thiram dust and the organic mercury dust ("Ceresan"-lime), and slight efficacy is also seen by the copper dust and copper-mercury spray fungicide, but only retardation of sporulation occurs by the zineb dust still more with Bordeaux mixture.

5. The distance action of the fungicide suggesting the presence of certain volatile fungitoxic substance is demonstrated clearly with the zineb dust, but slightly with the thiram and the organic mercury dust. The excellent preventive and therapeutic action of the organic mercury dust ("Ceresan"-lime) to the foliage diseases of rice plants is considered to be due partly to such a volatile fungitoxic principle, but the action of certain water-soluble substance or substances should also be taken into consideration.

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The influence of the vectors on the occurrence of viruses transmitted by aphids

Is there any Relation between the Existence of the Winter Hosts of Virus-Transmitting Aphids and the Occurrence of the Viruses Carried by the Aphids?

by Dr. E. Gersdorf, Department of Plant Protection, Hanover

With the knowledge that certain widely propagated plant pathogenic viruses are solely or mainly transmitted by certain aphid strains, an attempt has also been made to find one of the main reasons for the fluctuation in the occurrence of these viruses by studying the biology of the vectors. In 1953 Heinze maintained that there was a certain relationship between the existence of the "only" winter host of the green peach aphid *Myzodes persicae* Sulzer* (referred to in the remaining part of this paper by the abbreviation *M. p.* S.), namely the peach, and the existence of certain areas less affected by the potato viruses, the "healthy districts". But even the maps (1941, 1948, 1953) published by him do not definitely speak in favour of the view he holds, yet on these maps one of the oldest healthy districts, namely the area on the east

* With respect to the nomenclature, I have followed Börner (1952) chiefly because in his work "Europae centralis Aphides" he created a standard from which, with respect to nomenclature in accordance with the principle of continuity and the decisions of the International Congress of Zoology at Copenhagen, no deviations should be made, particularly as this name has generally been adopted in German phytopathological literature.

side of the Lüneburg heath, has in every year a "darker colour" * than many other districts.

The increase in the potato viruses — perhaps only apparent — about the middle of the thirties (Störmer 1937) which Heinze (1941) attributes to an increase in the cultivation of peaches — and at the time also to an increase in the cultivation of apricots — affected not only the area of North Hannover, however, but also in the same manner the province of Pomerania where from the very outset there have been very few peach trees. The situation, however, is confused by the fact that Mecklenburg which is located between North Hannover and Pomerania, and which also ranked between these two provinces with respect to its stock of peach trees, despite it having been equally affected by the increase in the peach stock and previously not having been a region of potato growing, has now become a potato growing area without anything having been done to reduce the existing peach stock. Since potato growing and the production of planting material can only be carried out practically in "healthy districts", Mecklenburg must therefore have become a "healthy district" even though the number of peach trees has not been reduced. However, Heinze (1941, 1948, 1949, 1953) adheres to his opinion, and merely points out the possibility of migration giving as the reason the prevailing meteorological direction of wind, such as is also emphasized again by Köhler in the discussion of Hansen (1941). Czerwinski (1943) made a similar statement. In 1942, however, Profft pointed out that one should exercise caution "in regarding the overwintering possibilities alone as being decisive for the degree of infection on potatoes". He also mentioned on the same occasion that the possibilities of the aphid reproduction as such and that of *M. p.* S. in particular are variably favourable in the different districts due to the climatic conditions. Although differing in the degree of clarity yet in a manner not to be misunderstood, Störmer and v. Bernuth (1947), Hochapfel (1949), Börner (1951), F. P. Müller (1949, 1952, 1954) and Rönnebeck (1952, 1953) maintain that the number of winter hosts in existence should not be regarded as being solely or chiefly decisive for the numbers of aphids occurring in spring and in summer. The investigations of the above are based solely on *M. p.* S. Further proof against the opinion that the number of winter hosts represents the main factor for the occurrence of certain virus diseases on plants is furnished — without being expressed — by Steudel and Heiling (1952), giving the example of virus yellows of beets and the difference in the extent to which this disease occurs in the district of Cologne and the adjoining western districts on the one hand and in the area around Bonn and the Pfalz on the other hand. Both are suitable areas for the reproduction of aphids, particularly the latter.

The investigations in the areas around Bonn and in the Pfalz are also based on *Aphis fabae* Scop. which, however, is not so important as *M. p.* S. as a carrier of the virus beet yellows. As far as I am aware, the extermination of the winter hosts of *M. p.* S. known at the time, as a useful measure particularly for controlling the first species in its capacity as a direct plant enemy

* On the maps the stock of peach trees per square kilometre is given in different shadings, whereby the smallest stock is not shaded and the largest stock is shaded most thickly.

and not as a virus carrier was first suggested by Börner and Schilder (1921). The same method was suggested by H. J. Müller (1951) and Heinze (1953) although the difficulty of this undertaking is obvious. Just the same the utterance of the opinion that the number of existing winter hosts has a considerable influence upon the number of virus-transmitting aphids and consequently upon the extent of the occurrence of viruses they can carry, has had its effect on the practice and has led to the local authorities issuing orders for the compulsory clearing of the winter hosts of aphids by uprooting. In 1952 Hey wrote that the authorities were not particular in the methods they chose by ordering these clearances, yet at the end of 1954 Köhler said that these measures are expedient.

Objections of an expert nature have now been raised against the measures carried out to eliminate the winter host on a wide basis, this in addition to the objections made by people having interests in peach growing. From the very outset attention was drawn to the anholocyclic overwintering. Opinions vary on the results obtained from investigations in Germany in the last few years (Heinze, Haine, F. P. Müller, Martini, Steudel and Burckhardt, Steudel and Heiling, Rönnebeck). Detailed studies have been made of the overwintering on *Brassicaceae* and in pits. In both cases it is established that their significance should not be overestimated. In the Hannover region they are practically without significance because it is only in very few years that there is an initial population of any note in autumn, and that moreover this population is not at all favoured by the weather. In fact overwintering does not even occur in marshy coastal areas, particularly in the area around Cuxhaven which because of its mild winter would appear to offer favourable climatic conditions, this being due to the fact that the high relatively humidity mostly prevailing does not promote the development of the overwintering pests. On the contrary the high humidity tends to promote the exposure of the insects present in late autumn to fungi, such as one can establish practically every year.

In summarizing it may be said that in most years the virginogenous autumn reproduction of *M. p.* S. in our region terminates so early that a noteworthy initial population for virginogenous overwintering outdoors does not exist. The possibility of extensive overwintering in pits is also reduced for the same reason. In fact the search carried out in pits produced practically no results at all, even though it was started too early in certain parts. *M. p.* S. have never before been found in pits except by Martini (1953) in the Weser area. *Myzotoxoptera tulipaella* Theob. was found in several places east of the Weser for the first time in the spring of 1954.

Regarding the importance of the greenhouses, it has as yet only been said that a large reproduction may take place in them. Investigations have still to be made to determine to what extent the effect of such reproductions spreads outdoors. So far I have only been able to establish a dense colonization of the surroundings of greenhouses in exceptional cases (cf. Heilmann 1952). In order to enable the alate insects produced in the greenhouse to escape outdoors, the outside temperature should not be very much below that prevailing in the greenhouse. It is only under such a condition that the insects

would leave the greenhouse at all. The clearance of the greenhouse may have a great influence when all aphids existing at the time escape outdoors. But even then the weather conditions must be so favourable that the populations migrating outdoors are not considerably decimated at once. It must, however, be considered that when aphid controls are not carried out in greenhouses, approximately the same numbers of aphids are actually produced every year because aphids are at all events more likely to be present in greenhouses than outdoors. The most favourable air-conditioning system cannot promote the reproduction of *M. p.* S. in early spring, say on overwintered cabbage when there are no insects at all present in the greenhouse.

Extensive studies in greenhouses have been carried out every year in the North Hannover district. The purpose of these was firstly to furnish information about the aphid infestation in general, secondly to establish the percentage of *M. p.* S. infestation, and thirdly to intensify the aphid control. It was hoped through this work to eliminate as far as possible the overwintering sources of *M. p.* S. to which great importance has been attached. From the results obtained, we believed we had a definite idea of the extent to which *M. p.* S. had propagated in greenhouses, and in fact it appeared that the pest was present in approximately 30 % of all the greenhouses investigated. In most cases, however, *M. p.* S. occurred only in small numbers. In 1954 F. P. Müller reported for the first time the occurrence of *Myzus ascalonicus* Donc. and established that this species differed from *M. p.* S. In consequence a number of samples were examined and it was found that in most cases it was not *M. p.* S. but *M. ascalonicus* which was infesting the greenhouses. I should like at this stage to express my thanks to F. P. Müller for the assistance he gave in determining the aphids. Since it is no longer improbable that *M. ascalonicus* has been present in our greenhouses for some considerable time and has been taken for *M. p.* S., there is some doubt as to the correctness of the results previously obtained in our investigations. It follows from this, however, that the infestation of our greenhouses by *M. p.* S. is even slighter than was previously assumed. It should, however, be taken into consideration that the entire area in North Hannover which is under glass, in comparison with the total area of the region, is much smaller than more densely populated districts (e. g. also South Hannover). It is extremely small in districts located west of the Weser, which cannot all be classified as healthy areas. For this reason it can be generally concluded that the greenhouses in North Hannover do not play any really notable part as "supply sources" of *M. p.* S., and consequently they are of no particular significance to the change in population density of this species during summer.

Most authors attach more importance to holocyclic overwintering than to anholocyclic overwintering. In addition to the studies already mentioned, I would refer in this connection to the study made by Buhl (1954) of *Brevicoryne brassicae* L. I fully agree with the opinion of these authors in respect of the area on which they based the investigation, namely the region covered by the Chamber of Agriculture, Hannover. However, the winter host complex in respect of the known healthy region of North Hannover becomes complicated in that in this area *Prunus serotina* Erhard (Hille Ris Lambers 1951, 1952, Völk 1954, Gersdorf 1955), one of the plants which in recent years

have been recognised as winter hosts, is growing in rather large numbers. In view of this the theory put forward at the beginning is upset even more than before. The district of North Hannover was a healthy area despite the presence of other winter hosts in addition to the peaches growing at the time, because the start of the large-scale cultivation of the American bird cherry in Lower Saxony by the forestry authorities (v. Wendorff, unpublished thesis) was in the period before and immediately following the first world war, although this cultivation had at least been attempted previously as proved by many old trees growing singly in the forests. It is not, however, only the oldest trees which are successful winter hosts, as Hille Ris Lambers believes, but also young plants may fill this purpose so that *M. p.* S. can, therefore, successfully use this species as a winter host irrespective of the age of the plant (cf. Gersdorf 1955 for further details). The discovery of other winter hosts, *Prunus nana Stokes* (Hille Ris Lambers 1951, Gersdorf 1955), and *Pr. serrulata shidare-sakura* (Gersdorf 1955) has at first no direct practical significance because these plants are only present in very small numbers, although they prove that even here there is still much to be done (cf. H. J. Müller, 1951). The lists of winter hosts of economically important aphids compiled by Börner 1952 will doubtlessly often be extended, even though in respect of *M. p.* S. the extent of the list of winter hosts compiled by Patsch (1938) will hardly be equalled.

In appraising the value of the different winter hosts for the spread of virus, Völk (1954) gives the peach preference over *Pr. serotina*, his reason being that the migrants flying from the winter host are virus-free. Möricke (1941) and others after him observed that practically fully-grown fundatrices or fundatrigeniae which fell from the winter hosts continued to develop on the plants growing beneath the tree. These plants could in fact — and probably were in many cases — be virus-infected potatoes. According to Völk this occurs more frequently with peaches than with *Pr. serotina* which chiefly grow outdoors. Apart from the fact that this involuntarily early colonization of potatoes can only occur to the extent in which fundatrices and fundatrigeniae exist on the winter hosts growing above the potatoes, it is by no means definite whether the fundatrices and fundatrigeniae falling on to the potatoes are able to continue their development to the same degree as, or to an even greater degree than on the original plant itself. At the beginning of June 1954, I had an opportunity of making observations in this connection underneath a seriously infected tree, and I found that the number of peach aphids present on the potatoes increased as a result of several aphids falling from the tree when the weather was favourable. This number, however, decreased more often than not. Most of the insects migrated and apparently died since they were not found again in the vicinity. Some of them, however, migrated up tree trunks and were able to find one of the two available peaches which made it worth their while. The *M. p.* S., however, showed little tendency to search for and migrate up tree trunks, although this was just the opposite with *Hyalopterus amygdali* Blanch. which were present on the same tree in just as a large a number. This species showed a preference for climbing up trunks or trained fruit-trees. Those *M. p.* S. insects which made use of apple trees or trained pears to migrate upwards remained on these plants just as little as those *H. amygdali* present at the same location. Unfortunately these observations could not be continued long enough because the peach tree owners had heard all but too early of "Systox" and had applied it without making many enquiries. Therefore the continued development of fallen fundatrices or fundatrigeniae on virus-infected potato plants may hardly be of any special significance even though such insects appeared very early in the fields. When the alate stage migrates regularly from peaches in the area of virus-infected stocks, the extent to which the migrants are previously loaded with viruses which can be transmitted depends firstly on the extent of the area covered by stocks which are mainly infected, and secondly upon whether the climatic conditions are in favour of a far-reaching swarm flight or not.

The assumption of Rönnebeck (1950, P. 354) that normally a smaller generation of fundatrigeniae occurs within a healthy region so that as a result few migrants leave the single peach trees, is perfectly correct. This, however, does not explain everything. These investigations which deal with the change in the population density of *M. p.* S. do show that in principle there are hardly any differences within Germany for the respective years, but that the numbers of aphids which occur as a result vary considerably. The "cardinal forms", however, also differ — these are: start and peak of the return flight of the gynoparae and ♂♂ of oviposition, the emergence, the fligth from the winter host — (Rönnebeck), insofar as such became known. With respect to *M. p.* S., the autumn reproduction is most important for the degree in which the winter hosts are populated, a condition which varies every year. However, it is presumed that this applies to the majority of, or all holocyclic aphid species. The autumns of 1949 and 1953 in particular were favourable for *M. p.* S. Consequently the return flight was greater during these two years than in any other year.

A comparison of the data given by a number of authors regarding the start of the return flight of gynoparae in Rhineland with my own data obtained in the vicinity of Hannover and the data of Halisch in respect of Uelzen (cf. Hofferbert 1943) shows that this flight began more or less simultaneously, and in several cases somewhat earlier; the greater part of the return flight occurred earlier in all cases, and also the return flight of ♂♂ — insofar as data were available from other regions — always began earlier every year, as in Central Germany (Müller 1954). The latest dates since 1947 were in 1954: 1st gynoparae Nov. 28, mass return flight of gynoparae did not occur, somewhat increased immigration as from October 4, first ♂ on October 7! As a result of the somewhat earlier occurrence of ♂♂ the laying of eggs also started every year during the first few days of October (Gersdorf 1955). Also in the autumn of 1953, the first egg was found on October 3, in other words earlier than stated by Völk (1954). The period of the return flight and also the egg laying which is even more apparent — and consequently the extent (Gersdorf) — is shortened in most years due to the fact that the peach very frequently loses the greater part of its foliage so early that only few eggs are laid. The conditions in our region are the same as those in Holland, as reported by Roepke (1949). It should not, however, be overlooked that the populations differ on each peach tree. This appears on the one hand, to be due to the differences in the variety. On the other hand, F. P. Müller (1954) points out that the closeness of weeds on which gynoparea are produced on the peach trees also appears to play a part in this. In our region it is not so much a case of differences in colonization during one autumn as to whether a noteworthy colonization actually occurs or not. The numbers of eggs per tree given by Hofferbert (1948) are admittedly abnormally large for conditions in North Hannover although on the other hand they are relatively small in comparison with results from other areas (Heinze 1953). During the particularly favourable autumn of 1953, the return migration lasted until November 20, an incident which had never before occurred since the beginning of my observations in 1937. But even during this particular autumn the average numbers of eggs laid were not even so high as the lowest figures quoted by several authors (Heinze, Möricke, Rönnebeck) for Rhineland or Berlin-Dahlem. There have been years, however, in fact those for which Rönnebeck quoted a "moderate" colonization, in which practically no eggs were laid at all. Consequently it is by no means surprising that single colonies are found in spring in which continued development can be observed. In fact certain experienced observers have at times discovered no colonies at all. Yet the emergence of the fundatrices in our area does not begin all that much later than in Rhineland. However, as the development of the winter hosts proceeds more slowly here than in Rhineland, in addition to the normal drop in the numbers of fundatrices (Rönnebeck) there is an even greater drop due to the weather conditions mostly being more unfavourable. In autumn, *Prunus serotina* is able to close the gap in egg laying in that it retains its foliage longer, as for example in the autumn

of 1954 when egg laying, even though to a small degree, was observed almost exclusively on this plant. This "advantage" of *Pr. serotina* over *Pr. persica* is frequently counterbalanced by the greater mortality of fundatrices and fundatrigeniae on the former.

The following example shows that these conditions cannot definitely be applied to other aphid species: In 1953 *Rhopalosiphon padi* v. d. G. occurred 14 to 20 days later than *M. p.* S. In 1954 *M. p.* S. appeared in very small numbers — later than usual, but at the same time as *Rh. padi* * which also occurred in small numbers, but at least ten days earlier than in the previous year. *Aphis fabae* Scop. also occurred a few days earlier.

On the other hand, Profft (1942) points out that the development of the fundatrigeniae colonies is dependent not only upon the number of fundatrices which survive the late winter and early spring but also, and in fact more so, upon the weather prevailing at this time. Reference has already been made to the delay of this development. But it is not only for this reason that the number of fundatrigeniae, and later the number of migrants in our area cannot be compared in any year with other areas. Corresponding to the number of eggs, numerous fundatrices emerged in the spring of 1954 but they died to such an extent that many winter hosts were free of aphids. Yet despite this, the state of infection as described by F. P. Müller (1954) was not to be found anywhere else. Furthermore, 30 to 50 % of the insects on the few peach trees in and around Hannover which were actually more or less heavily colonized on every second or third branch tip, were *Hyalopterus amygdali* Blanch. Profft (1942) was most certainly right when he pointed out that dry weather in spring promotes the development of fundatrigeniae. This cannot be based solely on the monthly averages (Profft) although the averages over many years prove that the farther we go west in Northern Germany the more humid are the critical months in most cases. This rule, however, is not exempt from frequent exceptions. But even a sudden fall of temperature — say a period of frost — may inflict considerable damage on the colonies. The area of the "Zentralheide" (Gersdorf 1954) is threatened in particular by late frosts, which is unfavourable for the aphids — although the frost endangers the potatoes too! (Other authors have also pointed out this fact, for example Hochapfel [1949].)

At this stage reference must again be made to what has been said above. As a result of the enforced decimation of the winter hosts, which started in 1940 in the eastern districts of North Hannover, extended in 1948 to the greater part of the governmental districts of Lüneburg and Stade, and supported by the prohibition of cultivation in the adjoining districts, there is no doubt that in places the numbers of existing winter hosts were reduced considerably (this is particularly applicable in view of the fact that the peach presumably was regarded — as in the past — as normally being the most efficient host). This reduction is also applicable when it is assumed that the number of *Prunus serotina* plants has increased in the oldest of the compulsory clearance areas since uprooting was started. This does not apply to the remainder of the area. This reduction, however, did not have any effect whatsoever on the number of existing aphids, but on the contrary there were more green peach aphids in the old clearance area every year than in many parts of the area which was cleared later, a fact which is not clearly expressed by

* I mentioned this species in my study of 1955, P. 8. It was determined by Hille Ris Lambers to whom I would express my thanks.

Völk (1953). In this connection it must be pointed out that the old clearance area is located almost completely in the district of "Ostheide" (Gersdorf 1954), a district which on the average has less rainfall in April and May than in the districts north and west of it, namely the "Zentralheide" and "Nordheide" where there are mostly fewer aphids. Allowance is also made for the fact that according to Hansen, the amount of rainfall is supposed to have no influence on the change in the population density of *M. p.* S., although with a corresponding distribution of rain which at this time of the year most certainly does not fall en masse in the form of thunderstorms, the relative humidity is undoubtedly reduced — and Hansen does not dispute the influence of the humidity. The fact that the recultivation results in old clearance areas, despite high aphid figures (Vogt, not published), are better than in the area cleared later still requires an explanation. In this connection it is pointed out that the success of the clearance of peaches in Pomerania — the percentage of other winter hosts in this state is unknown, however — was by no means accepted as such by those for whose benefit this measure was intended, even though the opinions are divided (Koltermann).

On earlier occasions it has been said, however, in many quarters that it is not the number of existing aphids, including the green peach aphid, which would have to be held responsible for the extent to which viruses are spread — a fact later proved by Hey (1952) and Rönnebeck (1952) — but that in potatoes the alate green peach aphid primarily spreads the viruses, and that the extent of spreading by this species was all the greater the younger the plants were during the aphid flight. This is made all the more evident the fewer infected plants there are at the beginning. In seriously virus infected stocks and their surroundings, the wingless aphids of the same species are also of importance, and in the areas infected by virus beet yellows the stages of *Aphis fabae* which are less inclined to migrate are also of significance (cf., however, F.P. Müller, 1954). The most endangered material, however, is to be found in the highest cultivation stages of potatoes in the breeding and reproduction area. Therefore it is argued in other quarters that the elimination of as many winter hosts as possible from the very outset reduces the number of the alate stage of every species occurring early in the year — the number is often so high that it cannot be recorded — so that consequently it would appear that the equation "Occurrence of virus infections to the presence of the winter hosts of the carriers" is formed.

There is no doubt whatsoever that the conclusion follows the discovery. It was at first known that certain healthy areas existed in which the virus control measures previously carried out — and these were certainly inadequate — had led to success much sooner than elsewhere. When it is clear that in these areas the reproduction conditions for the vectors were more unfavourable than in those parts where attempts to produce a healthy area failed, then the conclusion must be drawn that the reduction of the number of winter hosts could not produce the desired success. Without doubt, few overwintering sites in a vicinity favourable to aphid reproduction, including overwintering, are of greater importance than many overwintering sites in a vicinity unfavourable to aphid reproduction. This, however, does not

alter the fact that healthy areas are less suited to the peach than "degeneration areas". It should, however, not be overlooked that degeneration areas exist within the healthy areas, say the cities of Bremen, Hamburg and Hannover, although they are hardly comparable with the Rhine region. However, viewed from the aspect of the vector, this is not only to be attributed to the number of winter hosts — predominantly peach trees in this area — which is far higher than the number of healthy areas. Apart from the fact that in this region the area under glass is much greater, many peach trees are directly protected by growing close to buildings etc., so that they have a "small" climate more favourable to aphids (Profft 1942); even the city itself produces a "large" climate which in itself is more favourable to aphids than the surroundings (Geiger 1950). While discussing the same question, F.P. Müller (1954) points out that proportional to the size of the colonies the stocks of secondary hosts suitable for the production of ♂♂ and gynoparae also increase. It should be added — this will be dealt with later in a different connection — that in the immediate vicinity of villages the number of infection sites increases proportional to increases in the numbers of the population.

Moreover the number of the sources of infection here, just as anywhere else in degeneration areas, is considerably greater than in the healthy areas*. And the more intensively this cultivation level is exploited, which for potato breeding and seed potato reproduction is particularly high, the more it improves. The newly created healthy areas of Mecklenburg and Holstein are evident proof of this. This also furnishes the explanation for the fact already mentioned that the old seed growing districts of Lüneburg and Uelzen, despite the fact that the towns of Uelzen and Lüneburg were not included in the compulsory clearance campaign, are more favourably situated in respect of the recultivation tests than the adjoining districts in which the extensive and intensive exploitation for these purposes did not start until recently.

The following brief summary is given for those readers less familiar with the methods of potato breeding and seed potato reproduction: The breeder reproduces the clone of one variety intended for further reproduction, over a period of several consecutive years, and in doing so any virus-diseased plants which may occur are removed so early that they are not able to form tubers. Once he has attained the cultivation level "super elite" of one variety, he passes these on under his supervision for continued reproduction, and the following year the cultivation stage "elite" is produced, which in turn is followed during the next year by "high breed" and finally by "approved recultivation". The continued reproduction from the "elite" stage, or later the "high breed" stage onwards is carried out by reproduction organisations to which interested farmers belong, or by farmers at their own responsibility. The measures which are taken to preserve the quality of the plants also include "clearances", i. e. the removal of virus-infected plants and any tubers which may already exist followed by their destruction immediately they are detected — the sooner the better. To ensure that these and other measures designed to preserve the quality of the plants are carried out by the growers in good time, the competent Chambers of Agriculture have established an "approval service" in accordance with the legal provisions appertaining hereto. The "approval specialists" appointed by this service check the fields registered for the "approval" of potato plants and give either their approval or disapproval, the latter when the "clearances" (see above) have not been carried out satisfactorily. Naturally the standards in respect of the thoroughness with which the "clearances" should be carried out are all the greater the higher the "cultivation classification" is in which the crop is to be entered. Correspondingly the prospects of obtaining as few diseased plants as possible from tubers already infected the previous year are all the greater the higher the planted-out cultivation stage. From this it is evident that a region has fewer virus-infected plants when more fields are planted from the very outset for the

purpose of obtaining plants each with higher cultivation stages. The longer as large a percentage of potato growers as possible continue to "reproduce" within one area — in other words not growing solely for consumption — at the same time gaining experience, the better the overall "clearance" will be, the more the number of infection sites will drop in this area, and the higher will be the standard in the area covered by the "approval authorities". Therefore a better healthy area will be developed, that is to say of its own accord, as a result of the activities of the persons involved.

Mention should be made of the relation between the size of a village and the pressure of infection hinted at above. This was also established by Hansen, and which naturally is also existent in our region (Bibra 1949). This is understandable from two factors: 1. The small-scale growth of potatoes in gardens etc. in which smaller yields are avoided and infections are concealed as the result of thorough fertilization. 2. The slight interest shown by farmers in this region to grow seed potatoes because they are able to sell their potatoes for human consumption at favourable prices. Even though nearly all of them regularly change the seed, they fail to clear away virus-infected plants, with the result that the number of sources of infection is not reduced. When this is made noticeable also by larger numbers of aphids, then it is a reminder that virus-infected plants are preferred by *M. p.* S. and that they also represent a more favourable source of nutrition — insofar as the differences in number (cf. Kunze 1953) do at all provide a useful basis for investigation.

The following motive should be mentioned in support of the relation brought up for discussion. The alate aphids do not appear to be able to achieve their "aim" over long distances (Heinze 1949, F.P. Müller 1954); the prospects of the returning migrants of finding suitable winter hosts decrease the fewer there are available. This conclusion would be decisive if the numbers of alate aphids were to be the same in all regions per unit of time. This, however, is not the case, as explained. It would also presuppose an equal degree of oviposition, moreover the quota of surviving fundatrices would have to be the same everywhere, and also the number of existing fundatrigeniae — and consequently the existing migrants — would have to be an equal function of the number of fundatrices in all locations. These are all presuppositions which only apply in exceptional cases and even then not to a full extent.

Even though it cannot be overlooked that great efforts are required also in the healthy areas to keep these healthy, it must nevertheless be established that ecologically they offer to the virus vectors conditions which are less favourable than in other regions. To the same extent it cannot be overlooked either that aphids exist here and that they carry viruses. On the other hand it has been found that the time when the alate aphids occur, and not the number of aphids, is to be held responsible for the spreading of viruses, in other words for increasing their density per unit area (Hey). There are even differences of opinion in respect of the time when the alate aphids occur, although Schmidt (1952) and Völk (1953) can be compared. Their results are comparable for at least one year. What are the prerequisites which determine the occurrence of alate aphids? Several reports have been made about the time of the year when migrants occur on the peach tree. When the dates migrants occur in the different districts are compared, it is seen that there are very large differences each year, and the whole of the North Hannover

district is well behind. Whereas Rönnebeck (several times) and F. P. Müller (1954) observed that the flight period starts around the 5th of May, reaches its peak about May 15, and comes to an end about May 31, in our region these dates are about 12 to 15 days later, that is if there is a flight period at all which can be established as such. At this time, however, the potatoes — in particular the seed stocks — have emerged. It should be added, and this was presumed by Rönnebeck, that there is a great difference between the number of migrants in degeneration areas and the number in healthy areas, as has already been described. Mention should be made at this stage of the fact that both on *Brassicaceae* (Steudel) and in pits (Martini), the virginogenous alate aphids occurring here only represent a small percentage of the total number of alate aphids which colonize the potatoes early in the year. Just the same, even these aphids, just like any alate aphids which may originate from greenhouses, must have become infected at least once on diseased plants. This is all the less improbable the better they are able to exploit their desire to fly away from the winter host (Heinze 1953). Therefore they can only be directly dangerous when they originate on potatoes, which normally is not the case. In this event, it is their alate progeny originating on potatoes which first become active, and it is to be presumed that these are infected in the majority of cases due to the preference shown for diseased plants. Unfortunately there are no records available for the Hannover district showing where the first green peach aphids occurring on potatoes originate from, for the reason that they exist in such small numbers that they simply do not suffice for the purpose of obtaining statistical records. It is to be expected that even here the majority of aphids deserting peaches in years when the flight swarms are large are "persicogenous" — and it is only then that a small number can at all be raised. But these insects are not infectious at first, and whether they ever will be depends upon the opportunities presented which in the healthy areas are fewer than in the degeneration areas.

However, reference must again be made to the fact already mentioned that the take-off from the winter host in the degeneration areas is earlier than in the healthy areas. In my opinion the interval is so large that the first alate virginogenous aphids originating on potatoes can already exist in the degeneration areas before the migration from the winter hosts has got under way in the healthy areas. Therefore the question must be considered as to whether there is a possibility of at least a certain percentage of these alate, and partly infectious virginogenous aphids infiltrating into the healthy areas.

For reasons already mentioned, difficulties are encountered in obtaining direct proof which is either in favour or against this supposition. The numbers of alate aphids colonizing potatoes early in the year in the healthy area or also around its periphery are so small that they can neither be discovered nor caught. Even the "Möricke-trap" (Möricke 1951) did not prove successful. Just the same an attempt shall be made to draw a conclusion from the material available. From the 100 leaf counts made in our region (Völk 1953, and my own unpublished material) and the investigations carried out for the aphid warning service, it was established that the first aphids mostly found in June were nymphs, wingless virginogenous aphids and practically fully-grown

larvae, such as is also revealed by the investigations of Rönnebeck (1952) and Schmidt (1952). These first discoveries, in addition to single alate aphids and smaller larvae, were not made at the same locations every year. Therefore there was a very early initial colonization every year and at all locations, which had not been noticed previously because it was too small. F. P. Müller (1954) who had made similar observations on the same dates in Central Germany, is of the opinion that this colonization in June is of particular importance for the spread of the viruses in question. Since he draws attention in this connection to the dry weather which normally prevails in June and which makes the migration of alate *M. p.* S. easier (reference should be made, however, to Hansen!), it is pointed out that June is mostly the driest summer month in North Hannover too, although the amounts of rainfall in this month over an average of many years are higher than in other climatic regions, e. g. in Rhineland and in Central Germany. This early first colonization of the potato can be linked in our area in certain years with the observed departure from the peach, which of course could not be observed in the actual healthy area. The migration may of course have taken place from the *Prunus serotina* trees which previously were not heeded but this could hardly have been probable in those years when colonization and oviposition were hardly observed on the peach (Gersdorf 1955). The possibility should not be overruled that these may be the progeny of insects flying in from other regions.

There are many useful conceptions about the flight of aphids. Möricke (1941), Profft (1942) and later Ziegler (1952), Novak (1951 and 1952) and others refer to the finding of Elton which is interpreted by Palmén as follows:

"We find what might well be the most classic example that demonstrates to us in a binding manner the effective radius of the horizontal wind transport, in Elton's work (1925, P. 291) according to which large numbers of two insect species were encountered on the snowfields of the island of Spitzbergen, which with certainty had come from a point at least 1300 km away, in other words from the Kola peninsula at least. Of the two species, the one, *Syrphus ribesti* L., is a . . . good flier . . . while the other, *Dilachnus piceae* Pz., is apparently only able to fly at such a low speed that the most important factor, at least for the latter species, must be the wind."

The same authors also quote the height at which the insects fly as observed by Coad (4000 metres) and Bergland (500 to 2000 metres). Profft (1942) gives further details on this subject. Similar observations also concerning distances and heights flown by more fragile insects of other orders have been reported, e. g. *Simulium vittatum* Zett. over 950 kilometres from Greenland to Island (Lindroth 1931). Riggert (1931) reports on the flight of *Oscinis frit* L. Hase refers to the flight of mosquitoes from Australia to Tasmania (1954), which carried the myxomatosis of rabbits. According to Svärdson (1940), the fragile wheat midges were successfully propagated anemochor over a distance of more than 100 kilometres in South Sweden, i. e. they were still able to lay eggs after the transport. Data on the purely meteorological prerequisites for passive and active flight are to be found particularly in Geiger's work (1950), which were compiled and completed for the special subject of the aphid flight by Ziegler (1950), while successful work has ben carried out in respect of the biological prerequisites since Möricke (1941) and Profft (1942). It is in keeping with the subject that

observations were made chiefly on close flight and "landings", and that consequently prerequisites for field colonization were expounded (Steudel and Heiling 1954, H. J. Müller 1953). It is, however, also justified to bring in the flight observations in respect of other insects insofar as their flying habits do not deviate too greatly, qualitatively or quantitatively, from those of the aphids. Such observations are reported by Fränkel (1932), Speyer (1937), Tischler (1949). It is not intended to reprint in this paper the details given by these authors. I must also forgo giving details of the meteorological prerequisites for mass flights of insects from the particularly comprehensive studies of Palmén (1944), which were confirmed in respect of the potato beetle by Blaszcyk (1949). The fact that Palmén in his abundant material did not include any aphids is because the anemochor transports he observed followed hydrochor transports whose fragile insects were naturally not so developed. The same author also reports on the numbers of insects that can land on such occasions. He observed an average "landing" on the entire ice surface of a large Finnish lake of 2·5 small short-winged beetle (*Arpedium quadrum* Grav.) and 1·5 of two smaller dung beetles (*Aphodius sphacelatus* Pz. and *A. fimetarius* L.; this also occurs very frequently and in large numbers in our region but here it is in the minority) per square metre distributed rather evenly over the area of 1 square kilometre.

Studies made by the different authors have shown that the take-off of the single aphid is admittedly hindered by the weather but that the desire to fly of aphids ready for migration induces them to risk it even under unfavourable conditions (Haine 1954). Certainly the landing does not depend absolutely upon special favourable weather conditions, additionally since this may change during the flight. Haine (1954) reports about flight during unfavourable weather conditions:

I once observed a flight close to the ground, while it was raining. This was on July 10, 1954 at about 6 p. m. as I came out of the forest beyond Wolfenbüttel in the direction of Braunschweig, following several hours of heavy rain (from 3 p. m. onwards). It was raining so hard at the time and seeing that I was driving my Volkswagen at a speed of about 40 m. p. h., I had to use the windscreen wipers. Just the same a number of aphids immediately became caught between the wipers on the windscreen. I stopped, collected the insects, also from the front of the bodywork, the fender and the roof. I repeated this five times over the distance of 5 kilometres, and I collected altogether 1214 aphids. I would mention that I did not use the windscreen wipers again so that I had to reduce my speed. Among these aphids were definitely 378 *Aphis fabae* and 117 *M. p.* S., although I am sure a large percentage of those insects which were no longer in a state which would allow identification belonged to this species. Other species were also represented, e. g. 47 *Aphidula nasturtii* Kalt. (= *Doralis rhamni*). A light wind was blowing from the West over rather flat agricultural ground, and about 6 km away there was a cherry orchard, several allotments, and a number of houses with gardens. Some distance from the road I could see the edge of a forest in the direction of the flight. North of Braunschweig at about 8 p. m. there were hardly any flights to be seen although I was driving against the wind presumably in the direction of the flight whereas before I had been driving sharp to windward dependent upon the bends in the road mentioned above. The wind velocity, incidentally, was low, and I estimated it to be about 3 metres/second.

In view of what has been said above, intensive flights also over long distances cannot be disputed. Reference need not be made to the prevailing direction of wind (Heinze 1953) when discussing the healthy area in order to "guess" what is probably the main region of origin of aphids flying onto the

fields. A favourable transport wind blowing only three days from one direction, in which there are marked "aphid production areas", "performs" more than 27 days of varying wind from the prevailing direction of the wind, which moreover mostly carries humid and cold air with it. Such conditions occasionally prevail in our region every year at the end of April and in May. When a direct flight, say from Rhineland, is not observed under these conditions, it does not mean that it does not exist. Mention should be made that the wind veers upwards, as can be heard in every meteorological report given over the radio. The following is especially applicable to North Germany conditions: The climatic prerequisites that apply to the Lüneburg Heath and which influence the reproduction of *M. p.* S. also apply to a certain extent to the neighbouring cities, even though they are somewhat less pronounced, as already mentioned (Geiger). Accordingly the "value" of a city as an aphid production area is also dependent upon its geographical, or rather its climatological position. Therefore the same significance cannot be attached to these "degeneration areas" as say to the Rhineland. Should this be insisted on despite what has been said because these towns are in the immediate vicinity of the healthy area of North Hannover, then it must be considered that the number of alate *M. p.* S. produced is smaller than in Rhineland. It is not disputed that normally the number of transported insects decreases proportional to the increase in the distance covered from the starting point of the flight or that in many cases the insects do not settle over a very large area. It depends upon the frequency at which weather conditions prevail which are favourable for the start of the flight whether the "landing" takes place over large areas, even though this may occur on different days. However, the distant flight can by no means be disputed.

This distant flight, however, is of considerable importance to a healthy area. It not only increases the number of alate aphids already present but what is more important it also increases the percentage of infectious alate aphids because, as already mentioned, it should not be disregarded that the aphids deserting the degeneration area include a percentage of infectious insects which is much higher than that percentage occurring simultaneously in the healthy area. In this respect, it must again be pointed out that in the most extensive degeneration areas the reproduction may already be one generation ahead of that in the healthy area.

Practical proof of the influence exerted by the immigrants is to be found in hilly districts located close to a degeneration area, e. g. in Sauerland (Völk 1953). In this district there is also a small number of winter hosts or rather limited overwintering possibilities, and therefore it might well be regarded as being of no particular importance on the average over a number of years. Yet Sauerland is colonized relatively early in the year (Völk 1953), and in all probability the population increases during the course of the vegetation period. Of course the situation may at times be quite different as shown in the comparison of the start of colonization in Buir and in Hunsrück in 1951 drawn by Schmidt.

Despite the undisputable influence of the start of colonization the differences in the degree of colonization within single districts and the progress of colonization must also be discussed. Without any doubt the colonization

in degeneration areas increases more rapidly and more intensely than in healthy areas, a factor which most certainly is not without significance for the amplification of the local density of the virus occurrence. As proof of this, readers are referred to the figures published by Völk, although allowance should be made for the objections raised by Kunze (1953) to the results of the 100 leaf counts. It must be pointed that even Völk — in fact all who contributed to the material published by Völk were unanimous on this point — did not intend to imply that the figures he published represented absolute average values. They are merely a reference, just like the values published by other authors, to the order of magnitude in which the colonization takes place. Even in farming circles there are most exaggerated conceptions about the importance of aphid colonization figures for the health values of seed potatoes. On the other hand the figures given by Heinze in respect of Berlin-Dahlem and Pomerania, or our figures in comparison with those given by Steudel and Heiling for the same period, reveal inconsistencies which by no means can be disregarded.

Yet even within the boundaries of North Hannover, the conditions are not the same everywhere in respect of the progress of colonization and colonization density. In fact according to Völk (1953) and my own investigations there are considerable differences. In my own investigations I did not use the results of the 100 leaf counts for drawing comparisons. I visited on the same day several fields having the same topographical conditions and wherever possible the same variety and cultivation stage, and looked for aphids or only *M. p.* S. or stages of these within a unit of time which was the same for each field, observing the rules of the 100 leaf count. I then compared numerically the insects I had found in the same unit of time, by way of experiment also according to estimate. These counts were repeated once or twice in each field to ensure the degree of exactitude. The values obtained in this manner cannot of course be used as absolute figures or for comparisons, although the relative difference between two areas can be determined. The results obtained corresponded in general to the predictions, and accordingly they did not differ considerably from the results of the 100 leaf counts carried out.

I fully realise that the above method of determining the varying degree of colonization in one area by one particular aphid species involves the error that a difference established in this manner may be purely temporal in that in one area the maximum of an aphid colonization may be reached later than in another area. Therefore such an investigation must be carried out as frequently as possible and allowance must also be made for the overall weather situation in order to establish whether such temporal reproduction differences have to be taken into account. Details cannot be given here. The compilations of Völk show, however, that a later maximum from the time aspect also often results in a quantitatively smaller maximum.

At this stage I would include several remarks about the normal development of the change in the population density of *M. p.* S. and other aphids in the Hannover area. The 1939 values published by Profft (1942), which he compares with those of other North German regions, are record values, as revealed by Völk (1953) in respect of certain years, although this also applies to the other years. Likewise the fact reported by Profft that in July 1939 *M. p.* S. occurred in larger numbers than *Aphidula nasturtii* Kalt (= *Doralis rhamni*) and *Cerosiphon gossypii* Glover (= *Doralis frangulae*) together is an exceptional phenomenon. Normally it is just the reverse. This merely shows that the latter two species are also — and this is most definitely not parallel — subject to a change in population density of their own which varies from year to year. In respect of the change in the population density of *M. p.* S. the following may be said for the Hannover area: Normally the aphid occurs in the Hannover highland (Gersdorf 1954), particularly in the valleys and on the borders as well as in the Westheide, on a larger scale and, as far as can be perceived, somewhat earlier than in the remainder of the area. In the area of South Hannover, the large number of greenhouses can be held responsible for this, but not in the Westheide. In the remainder of the North Hannover district, the Südheide and Ostheide are mostly more densely

colonized than other parts of this district. Heinze (1939) mentioned the great difference between the colonization in the vicinity of Celle and that around Soltau in 1937. The start of the colonization in these districts, however, does not appear to vary temporally although there is a difference in the intensity of the initial colonization. Regarding the infection around Stade, Profft (1942) shows that the conditions are just the reverse to what they are normally, although Heilmann showed on the basis of investigations carried out over several years that the infection around Stade is relatively slight and also very late. However, in this case the conditions in certain localities are of a special nature in that the bogs are definitely unfavourable for the existence of aphids because of late frosts and considerable fluctuations between the day and night temperatures. The same applies, of course, to all other bogs and fens, particularly high moorland (cf. Peus 1932). In this connection, attention is again drawn to the fact that the months important for the early development of *M. p.* S. have over an average of many years become more humid and cooler to the West and North West. This furnishes an explanation for the slight average aphid development even though special cases occurring in certain years leave their mark on the change in population density. There is, however, no sign that the first colonization in these areas is basically later than in areas which later are heavily colonized. It is merely slighter due to the reasons given, in fact so slight that it is practically not determinable. The effects arising out of it, however, are most curious.

In autumn there is a lack of a perceptible "second" reproduction peak on potatoes over practically the whole area. It is only occasionally that there are signs of it on this crop. In certain years it is more evident on *Crucifereae* whereby at the same time the start is given for the return flight to the winter hosts and, as already mentioned, for the anholocyclic overwintering, insofar as the colonization does not terminate early. The colonization of beta beets is extremely slight every year. Even in South Hannover there is hardly any reproduction on this crop. It was merely in 1954, a year of extremes, that several wingless *M. p.* S. were found in July before the start of the rainy period, but this was only after a thorough search had been made. However, even in these fields the degree of infection was most certainly below 0·01 aphid per plant. The figures given by Steudel and Heiling have never been equalled in our area either. Halish too found single insects, and always in late summer, with one exception that in 1951 after a long search he discovered a seedling field which was moderately infected by *M. p.* S. This field had been drilled very late in the season. But even this infection disappeared so completely before the harvest and the storing that even those plots which were not treated in the control tests carried out with insecticidal dust were completely free from infection the following year. For this reason investigations were also carried out on potatoes in South Hannover on behalf of the aphid warning service responsible for early seedling sprays (cf. F. P. Müller 1954).

The conditions in respect of *Aphis fabae* are, of course, somewhat different. 1947, 1949 and 1954 were serious aphid years. However, the values given by Steudel and Heiling, and in fact those reported by H. J. Müller (1953), are never equalled by this species either. In many years the factory beet stands remain practically free from infection, and only a few of the seed bearers are infected. This species could definitely not have participated in the serious occurrence of virus beet yellows in the summer of 1950.

It appears as if the propagation of aphid-transmitted plant viruses in healthy areas is not caused by vectors occurring in these areas but that the extent of damage is dependent upon the production of vectors in other areas which may be a considerable distance away and upon the immigration from those areas insofar as there are not other reasons which are responsible for this (number of sources of infection etc.). The conception of the immigration or partial immigration of harmful pathogens is by no means strange in phytopathology. Examples of this are the drifting of black stem rust spores to the South of Sweden over the Baltic Sea, and the considerable damage frequently caused as the result of feeding by migrating butterflies (cabbage white moth: Speyer 1948, *Plusia gamma:* Kanerva 1947, *Agrotis ypsilon:* F. P. Müller 1949, wheat midges: Svärdson 1940). More examples could be given as required. Based on *M. p.* S. this would mean from the faunal aspect, that North

Hannover represents the boundary region for the occurrence of *M. p.* S., and in which the species does not exist outdoors the whole year round every year but that following a very strong decline or even a temporary extinction outdoors it must first be introduced as the result of immigration from regions which climatically are more favourable for development — from the biological aspect the greenhouses must also be included among these regions. North Hannover is, therefore, not a region where there are changes in population density as according to Tischler (1949) but belongs to the sub-optimum Pejus zone as according to Friederichs (1930). Even this is not out of the ordinary but applies to many other insects in the same or a somewhat extended area, namely Lower Saxony north of the Lößschwelle and Western Holstein (in other words not the whole Atlanticum as according to Werth, 1929). *(Lepidopterae:* Warnecke, *Coleopterae:* Horion, special literature for Hannover, compiled by Gersdorf 1949 and 1954). This does not alter the fact that *M. p.* S. is referred to as a cosmopolitan. Lindroth (1931) did not report it as occurring in Island, and in Finland it is a pure greenhouse aphid * according to Heikinheino (1944). The transition zone (Pejus zone, see above), as represented by North-West Germany according to the Hamburg and Bremen faunologists (in other words excluding Westphalia and the Lower Rhine), will probably extend in a more or less wider zone through the entire Palae Arctic. The same train of thought is followed by Esbo (1946) who attempted to determine sub-optimum zones for *M. p.* S. in Sweden in order to render these useful for seed potato production. Van der Plank (1944) writes along similar lines in determining sub-optimum Pejus zones for *M. p.* S. in South Africa.

A further investigation would be necessary to establish which propagation type *M. p.* S. belongs to within Germany. A number of insect species which do not, or only occasionally occur in North Hannover, do not or hardly ever pass the highland crest in which case, therefore, more or less the same conditions in respect of the occurrence of the species in question apply to the whole of North Germany. Other species penetrate east of North Hannover as far as South or Central Sweden which means that the Ostheide may be affected. The studies made by Esbo indicate that *M. p.* S. belongs to the latter propagation type. This, however, is not supported by the description F. P. Müller (1954) — in agreement with Schick — gives in respect of the division of Central Germany according to the suitability of the different regions for seed potato production. Kalela (1944, 1949; other literature is also available) reports on the boundary regions in respect of occurrence and their temporary occupation as the result of migration, although this report deals with vertebrate animals. On principle these factors should not be any different for insects, as the above-mentioned author assumes (cf. Palmén 1944).

The presentation of the knowledge given above would also be necessary even if it were not known that apart from the peach tree there are other winter hosts whose value for the aphid is also dependent upon the weather. At the time when the "knowledge" that the extent of the occurrence of carriers of plant pathogenic viruses is dependent upon the number of possibilities per unit area available for the holocyclic overwintering of vectors, quickly became clear to growers producing seed potatoes, the thought occurred to handle all discovered winter hosts and any which might come later in the same manner as the peach (Köhler 1954). It must, however, be pointed out

* Lindroth (1949) proves that Central or South European faunal elements live synanthropically in Fennoskandien. The same applies in Central Europe to a large number of sub-tropical and tropical faunal elements. Börner (1952).

that this is not possible. Apart from the fact that the single plants cannot all be found — the same also applies for example to the winter hosts of other aphid species insofar as these are not cultivated plants, in other words *Viburnum* and *Evonymus* plants — forestry for example can hardly do without *Prunus serotina* whose cultivation merit is proved by v. Wendorff (unpublished thesis) (soil amelioration, wind protective hedges on driest sand etc.). Furthermore it does not appear at all impossible that further winter hosts will be found and that known hosts for some reason or other will also be made particularly suitable for cultivation or that hosts so far unsuitable will be made suitable by breeding new varieties or forms, which appears to be more promising than that the aphid adapts itself to new conditions. Furthermore the objections of the usufructuaries of aphid winter hosts, who are hardly interested in the virus control or virus infection reduction on cultivated plants which do not fall under their usufruct, may at least make a compulsory clearance more difficult as this has often been done on a considerable scale, and often with success. In this connection attention is drawn to the legal considerations which arise out of the fundamental law and which often enough have been put forward against compulsory uprooting but which have never been expressed before court. Moreover the advantages which the compulsory clearance of a part of the winter hosts of *M. p.* S. undoubtedly has had psychologically for certain classes, should not tempt one to remain at measures which technically have proved to be inadequate.

However, in future it should be borne in mind that the number of winter hosts existent in a certain region, at least in the case of *M. p.* S., is of far less importance for the occurrence and the change in population density of this species and consequently for the propagation of the most important viruses transmitted to root crops by this species, than has previously been assumed in wide circles. Concerning the occurrence of the viruses themselves other problems have to be faced. Of these reference is made merely to the opinions of Rippel (1948). Hey (1952) too, assumes that the development of the viruses themselves appears to be subject to certain ecological factors which are still unknown (cf. E. P. Müller 1954). Although objections are raised against the argumentation of Hey (Rönnebeck 1954), and further objections might be raised, the assumption itself may be perfectly correct. There is no reason, in the scope of this consideration, to go into details on these points. However, the conclusions to be drawn increase the significance of the measures which potato breeders and seed potato producers always carry out in their own interests. Apparently they compel one to try out and work out other methods for improving the quality of the seed (Hofferbert 1947). Consequently ideas are gained for preventing the widespread occurrence of other virus diseases of plants.

As the considerations discussed here apply, however, primarily to the virus vectors, it must be contemplated what is to be done in respect of these now that the previous measure for eliminating the winter host has proved to be insufficiently thought over.

The conclusions to be drawn are, in my opinion, as follows: Spraying of the peach trees should not be dropped but in years when large numbers of eggs are laid, these sprays should be intensified. However, as the emigration from the other winter hosts, when it is necessary in one particular year, and the immigration from far and near cannot be warded off at the original location, it must be the aim of virus controls to protect the threatened plants themselves and to eliminate the sources of infection. Insofar as direct vector controls must be striven for, it is necessary to establish a warning service which

would notify growers of the dates to start spraying, and which would not only be located in the healthy area itself but also extended over the other areas, in particular the degeneration areas. For such a service, a few well-organized observation stations are, in my opinion, more important than many which cannot deal with the work to the extent desired. However, it is not intended to go into detail about this in this paper.

Summary

On the basis of the above-mentioned investigations carried out by others as well as on the basis of my own observations on the temporal and quantitative occurrence of the green peach aphid, it is concluded that the following conditions, which deviate from those of other areas, exist in the North Hannover potato breeding and seed potato producing region:

The occurrence and the change in the population density of *Myzodes persicae* cannot, in most years, be inferred from the intensity of egg laying on the chief hosts. Even the emergence, the development of the fundatrices and the fundatrigeniae seldom provides a positive and useful basis for such an inference.

Wherever oviposition, emergence and take-off of migrants occur at all on a scale which can be observed, the corresponding dates and the numbers of the insects remain well behind those of other regions.

The first colonization of the potatoes is temporally seldom behind colonizations observed in other areas although quantitatively it is well behind the corresponding figures of these other areas. The peak of the occurrence is later and mostly it is well below the maxima of other areas.

It is concluded that the region of North Hannover as a "healthy area" belongs to the sub-optimum Pejus zone of *Myzodes persicae.* The annual "change in population density" is, therefore, to a certain, and sometimes considerable degree dependent upon the immigration of alate aphids. This immigration increases the danger of early infections occurring.

Therefore measures which are intended to have a premature effect on the change in the population density, e. g. the clearance of winter hosts, cannot lead to the desired success. They can only be of certain importance in exceptional years, although even in such years the migration does not lose its significance.

The migration of alate aphids over very large distances is feasible, and particularly good weather is not a necessity for this. On the other hand the migration can take place from any direction. Consequently the prevailing direction of wind is not of particular importance.

The quality of a healthy area is not dependent upon the change in the population density of the vectors alone. Special significance is attached to the reduction in the number of the sources of infection. This is done all the more thoroughly, the more comprehensively seed potatoes are produced in a healthy area.

Insofar as plants threatened by vectors must be afforded protection, these measures should be carried out at the proper time on the plants themselves which are to be protected. Controls carried out on other plant hosts to the vectors are practically futile.

In order to be able to carry out these protective measures in good time, the occurrence of the alate vectors must not only be observed in the seed potato producing and breeding areas themselves but also over a wide area. and particularly also in the degeneration areas.

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Annual reports on aphid counts, aphid warning service, supervision of greenhouses and studies of anholocyclic overwintering of *M. p.* S. Information bulletins in the scope of the warning service. The data for these are prepared not only by the Division of P. C. but also by outside co-workers, in particular a number of seed potato breeders and beet seed breeders.

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